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ELECTROCHEMICAL AND ELECTROMETALLURGICAL DEVELOPMENTS IN CANADA.

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Part II.

The first part of this paper dealt with the present condition of electrochemical and electrometallurgical industries in this country. The list of plants in actual operation is not very imposing. That, however, this country is only at the threshold of an immense electrochemical development must be evident to even the least observant. The factors which up to the present have combined to retard the industrial progress of the country —"sparse population, great natural obstacles to transportation, peculiarities of geography, and our proximity to the more wealthy country to the south"—all these factors are either removed or else neutralized so as to exert little or no effect. The rapid growth in population, combined with the discovery of enormous natural resources, must lead to an unprecedented industrial development, and, considering the abundant water-power facilities of the country, the greatest developments must take place in the application of electrochemical and electrometallurgical processes.

In considering the question of the location of an electrochemical industry a number of factors have to be taken into account. There is, first of all, the problem of raw materials, secondly that of power, and thirdly that of transportation facilities. Other problems must undoubtedly occur in different cases, but in general the above are the main factors upon which the question of the location of an electrochemical industry depends.

The discussion of the possibilities which Canada offers from an electrochemical point of view must, therefore, fall under the following three headings:

I. Mineral Resources.
II. Water-Power Resources.
III. Transportation Facilities.

In attempting to discuss these questions on this occasion I do so with the full knowledge that they involve not only electrochemical but also purely economical and even political considerations, in all of which few are capable of expressing expert opinion. What has, indeed, stimulated me to attempt a discussion of such a complex subject on this occasion, is not the feeling that I can cast a sort of inspired light upon the problems involved, but the fact that this is the first occasion on which a distinctly Canadian city has been honored by a meeting of the American Electrochemical Society, and it is only fitting that on such an occasion attention should be drawn to the possibilities which we believe this country offers of exploitation by the electrochemist and metallurgist.

I. Mineral Resources.

The following remarks, based on the reports of the Conservation Commission, give a general idea of the mineral resources of Canada: "It will be noted from a mineral map that the greater portion of the country is as yet unprospected; about one-third lies within the prospected area and two-thirds without, and that the mineral resources have been developed (leaving out the Yukon) practically only in the territory lying fairly near the southern boundary. Even the portions of the country represented as being within the prospected territory must not be considered more than partially explored for minerals, as new discoveries are continuously being made within the supposed prospected areas. This has been the case at Cobalt, with the iron ore deposits of the Mattagami, and with the coal at Yellowhead Pass. It will, therefore, readily be seen that the unprospected area is very great, and, considering that much of the northern area has the same promising geological formation as some of our known developed deposits, it is reasonable to suppose that our mineral product will be greatly increased in its development."[1] In fact, wherever prospecting has been done farther north indications of valuable minerals have been found, and, by accident, great wealth has been uncovered in some cases.[2] It is not at all an exaggeration to state that nine-tenths of Canada's mineral regions are not yet explored.

At the present time the mining industry of the country is second only to agriculture. Its growth has been very rapid. In 1886 the total mineral production was slightly over $10,000,000; in 1909 it had grown to $92,000,000, and in 1910 to $105,000,000. In other words, the increase in 1910, as compared with the previous year, is greater than the total production twenty-five years ago. Of this total, slightly less than half consisted of metallic products. The statistics of the individual products are given in Table I.

(1) C.M., p. 406.
(2) C.I., p. 9.

TABLE I.

The Mineral Production of Canada in 1910.[3]

Metallic.

Product.	Quantity.	Value.
Silver' (ozs.)	31,983,328	$17,106,604
Nickel (lbs.)	37,271,033	11,181,310
Copper (lbs.)	56,598,074	7,209,463
Gold		10,224,910
Pig iron from Canadian ore (tons)	104,906	1,651,321
Iron ore (exports) (tons)	114,449	324,186
Lead (lbs)	32,987,508	1,237,032
Zinc ore and other products		235,000
Total		$49,169,826

Metallic.

Product.	Quantity.	Value.
Coal (tons	12,796,512	$29,811,750
Asbestos (tons)	75,678	2,458,929
Asbestic (tons)	24,707	17,629
Natural gas		1,312,614
Gypsum (tons)	513,313	939,838
Salt (tons)	84,092	409,624
Petroleum (bbls.)	315,895	388,550
Corundum (tons)	1,870	198,680
Other non-metallic products		1,100,664
Total		$36,438,278
Structural materials and clay products		19,432,854
Total mineral production		$105,040,958

When compared with other countries it is seen that Canada ranks well among the mineral producing countries of the world. In 1908 it stood first in asbestos, first in nickel, third in chromite, third in silver, seventh in copper, eighth in gold, and tenth in coal.[4]

The per capita production has increased from $2.23, in 1886, to $12.82, in 1909.[5] This compares favorably with the per capita production of approximately $17.00 in the United States. It is more than likely that in the next few years Canada will approach the latter figure much better.

The bulk of the mineral production of the country is at present derived from three provinces. In 1910 the proportion of the total output produced by each of these provinces was as

(3) These statistics are take from the Preliminary Report on the Mineral Production of Canada, 1910, and are subject to revision.

The total pig iron produced was 800,787 tons, but from this has been deducted 695,891 tons, which was cr dited to imported ores.

The lead production was about 13,000,000 lbs. less than in the previous year, which "was due largely to the curtailment of production by several of the important Slocan mines consequent to the destruction of railway facilities and of several mine buildings by forest fires."

(4) C.M., p. 406.

(5) R. 88, p. 9.

follows: Ontario, 40.95 per cent.; British Columbia, 23.37 per cent.; and Nova Scotia, 13.38 per cent.

In the following sections different mineral resources have been treated at greater length. For a great deal of the information I am indebted to the splendid report on minerals issued by the Conservation Commission of Canada during the past summer. I have also made free use of the various bulletins issued by the Department of Mines at Ottawa. These form a veritable mine of information on Canada's resources.

Gold.—The gold production of Canada is mainly derived from the Yukon and British Columbia. The exhaustion of the richer gravels of the Yukon has led to a diminished but much steadier exploitation of the placer deposits. The production from this territory in 1910 was $4,550,000. "The future production will probably increase annually, owing to the mining being put on a more stable basis, due to the reduction of costs and the advent of large companies. Large companies are carrying on extensive operations for dredging and hydraulic mining for the purpose of working over the old tailings and large deposits of low-grade gravel."[6]

The gold production of British Columbia was $5,432,000, in 1910, most of it being from auriferous copper pyrites ores in the Nelson and Rossland districts. It is a question whether electrolytic methods of treating these ores would not be found to be more economical than the present metallurgical methods. In the treatment of the auriferous gravels of the placer deposits it is very likely that some process of electrolytic amalgamation might also be found to yield better results than the ordinary amalgamation methods. The remarks of E. E. Carey[7] are worth while quoting in this connection.

"In the near future we may look for a greatly increased production of gold, due to the application of electrochemical methods in mining and milling operations. Were electro-amalgamation and electro-cyanidation to-day in general use in other mills now in operation, the gross output of gold would be increased twenty-five per cent. The great increase in the future supply of gold, however, will come from vast low-grade deposits and ledges, which cannot now be economically mined."

That the gold resources of the Yukon and British Columbia have only been skimmed, as it were, is evident from the fact that the mountain ranges of this territory in which gold deposits have been found so far form the northern extremity of the "western or Cordilleran belt, which, extending from South America to Alaska, is recognized as one of the greatest mining regions of the world, noted principally for its wealth in gold, silver, copper, and lead." In both Mexico and the United States this moun-

(6) C.M., p. 408.

(7) The Electrolytic System of Amalgamating Gold Ores. Trans. Am. Electrochem. Soc., 19, 127 (1911).

tain range has yielded about $3,000,000 per mile of its length, and it is only reasonable to expect that Canada, which possesses over 1,300 miles of this range, will yield enormous amounts of the precious metals in the future. The resources of placer gold in the Klondike alone have been estimated at $100,000,000. Up to the present probably not one twentieth of this vast area has been prospected in detail.

Silver.—About 90 per cent. of the silver produced in Canada in 1910 was derived from the rich silver deposits of Cobalt, Ontario, the rest being derived from British Columbia. Since the discovery of the Cobalt deposits, in 1904, the production of Canada has grown rapidly; in 1910 this country produced 32,000,000 ozs., or 13.3 per cent of the world's total production.

Fine silver is produced only at Trail, B.C., as a by-product in the lead refining process. "In Ontario ores from the Cobalt district are at present being treated at three metallurgical works operated by the following companies:

The Canadian Copper Co., at Copper Cliff, Ont.

The Deloro Mining and Reduction Co., at Deloro, Ont.

The Coniagas Reduction Co., at Thorold, Ont.

"Silver bullion of fineness varying from 850 to 998.2 is produced at the works, other products being white arsenic, and in the case of the Coniagas plant, nickel and cobalt oxides. In each case residues carrying silver, arsenic, cobalt and nickel are either shipped to the United States or held in reserve for further refining. In 1909 about 52 per cent of the total silver production was recovered in Canada as fine metal or bullion."[8]

The ores of the Cobalt district are extremely complex, and the problem of treating these ores economically is still awaiting a solution. Under present conditions one of the pressing needs for the further promoting of mining and metallurgical activity in northern Ontario is the devising of suitable methods for the treatment of the Cobalt silver ores. Only about thirty per cent. of the ore shipped from Cobalt in 1909 was treated in metallurgical works in Canada, most of this being high-grade silver ores, and the rest was shipped to a number of large companies operating in the United States. "With respect to the content of nickel, cobalt and arsenic in the ores, the mining companies are paid only for a small portion of the cobalt content, and nothing for the nickel and arsenic; in fact, in certain cases, the latter two are penalized."[9]

Another interesting problem in connection with the cobalt silver ores, is what to do with the cobalt. The situation is described in the report of the Bureau of Mines of Ontario for 1910, as follows:

"The cobaltic oxide trade is at present demoralized, and is likely to remain in this condition until a greatly increased use

(8) R. 88, p. 107.
(9) R. 88, p. 109.

of the article enables the demand to overtake the supply. The enforced production of cobalt ore from the mines of Cobalt has resulted in a much greater quantity of ore than can be converted into oxide and marketed as such. In fact, one year's operation of the Cobalt mines will produce ore enough to meet the present consumption of oxide for several years. The inevitable consequence has been a very decided fall in the price of cobaltic oxide. . . . . . Cobalt ore cannot at present be sold, and none is being raised from any of the silver-free veins of the Cobalt camp, the entire production being of ore associated with silver. . . . The only hope of absorbing the cobalt contents of the ores which will continue to be produced in Ontario is in an enlarged demand, brought about either by the low levels to which the prices have fallen, or by new uses for the product. It is not unreasonable to expect that the former will lead to the latter."[10]

In the solution of these problems there is undoubtedly a field for the electrochemist and electrometallurgist. Not only is there an abundance of mineral wealth in the Cobalt region itself, but even in the districts farther north deposits of the most varied nature have been unearthed. Iron, copper, molybdenum, silver, gold, and even small diamonds have been discovered in the lone land south of Hudson's Bay. The whole of the Temiskaming region appears to be a vast mineral deposit where the richest ores and minerals of the earth have been thrown together in the past ages, in a most haphazard and extraordinary manner, so that one knows not what to expect in the future. Added to this is the fact that there are abundant waterfalls throughout the whole region. The facilities for transportation are being increased as fast as the country demands them; the government of Ontario has constructed a direct line to open up the agricultural and mining districts of the north of the province and is operating it by a commission. All these considerations serve to emphasize the fact that the hopes which are entertained for the electrochemical future of northern Ontario are not without some warrant.

Copper.—The copper production of Canada is derived from the provinces of British Columbia and Ontario. The production for 1910 from the first named province was about 36,000,000 lbs., most of this being derived from the Boundary district. The ores carry a low content of copper metal, but the smallness of the copper content is more than compensated by the fact that the probable reserves of metal in the province are enormous.

In Ontario there are many deposits of copper around the north shore of Georgian Bay. Some of these are being developed gradually. The great difficulty in the development of these deposits is the lack of a smelter, as the miners experience difficulty in marketing their ore under present conditions of trans-

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(10) B.M.O., p. 24.

portation.[11] It may be noted that similar conditions obtain with regard to the exploitation of the copper deposits of the province of Quebec.[12] The copper production of Ontario is, however, mainly derived from the nickel copper ores of Sudbury, which are discussed in the next section.

Of interest to the electrochemist is the fact that "no refined copper is produced in Canada, but the copper ores are mostly reduced to a matte or blister, carrying values in the precious metals,"[13] which is then exported. In 1910 the total exports of copper contained in ore, matte, and blister, according to Customs Department returns, were 56,964,127 lbs., valued at $5,840,-553 (practically the whole of the production), and imported in the same year 30,237,106 pounds, mostly in the form of copper bar, strip, rod and plate. As was noted in a previous paragraph, the production of British Columbia alone was about 36 million pounds.

Considering the facilities for the development of hydro-electric power in the latter province, it is surprising, at first glance, that no copper refining plant has as yet been established in the Boundary district, especially when it has been found possible to operate a lead refining plant on a paying basis. To refine 30,000,000 pounds per annum would require a plant with an approximate capacity of fifty tons per day—no mean size, when it is remembered that the Balbach refining plant had this capacity in 1903 and was utilizing 750 h.p.[14] There seems to be no other reason for this state of affairs than the fact that, as the history of copper refining in the United States has shown, there has never been any general tendency to establish refineries near the mines. With very few exceptions, "the refineries from the earliest times have been established in the market centres of the East. They stand between the producer of crude metal and the consumer, and experience has shown that they are best placed at a distributing point for the territory of consumption which they are to serve."[15]

Nickel.—The discovery of the copper-nickel ores in the Sudbury district has placed Ontario in the position of being the largest producer of nickel in the world. These deposits now supply over 75 per cent of the world's total production of nickel. The main producers at present are the Mond Nickel Co., at Victoria Mines, and the Canadian Copper Co., at Copper Cliff. The former is an English and the latter an American company. The ore is first roasted and then smelted and converted into a bessemer matte, containing about 45 per cent. nickel and 35 per cent. copper. The total production of this matte in 1910 was 35,033 tons, containing 19,259,016 pounds copper and 37,271,033 pounds

(11) R. 24, p. 313.
(12) Summary Report of the Mines Branch, 1909, pp. 69-74.
(13) R. 102, p. 10.
(14) T. Ulke, Trans. Am. Electrochem. Soc., 3, 224 (1903).
(15) Ingalls, Lead and Zinc in the United States, p. 78.

nickel.[16] The whole of this matte was exported to the smelting works of the two companies in England and the United States, while Canada imported over $23,000 worth of nickel and nickel anodes.[17] As Dr. Haanel has expressed it:[18] "We mine the ore, smelt it into matte, and send it as such out of the country. If we want nickel or nickel steel we have to import it. . . . Not only are these deposits of little material value to the country at present as exploited, but the method practised is exceedingly wasteful." Dr. Haanel has, in the same connection, indicated one method by which the ores might be treated so as to prevent this wholesale exportation. His scheme in brief consists in magnetic separation of the iron and magnetic nickel from the copper, precious metals and non-magnetic nickel compounds, followed by electric smelting of the iron-nickel portion to form ferro-nickel and electrolytic treatment of the tailings, as is practised at present in dealing with the matte. "The introduction of such a process, which would treat tailings containing the copper and part of the nickel by the electrolytic process in operation at Fredericktown, Missouri, and patented by Mr. N. V. Hybinette, would be in the interests of economy. A refiner, established in the Sudbury region on the plan outlined, would enable Canada to export finished products instead of the matte, as is now done."

Nickel also occurs associated with iron and sulphur as pyrrhotite, the percentage of iron averaging about 60 when the ore is pure. The experiments conducted under the direction of the Department of Mines, at Sault Ste. Marie, have demonstrated that a good ferro nickel pig can be produced from the smelting of roasted pyrrhotite by the electro-thermic process.[19]

Iron.—In discussing the iron ore resources of the country and their probable exploitation by means of electro-thermic processes, I am well aware that the subject has been abundantly discussed within the last few years. The facts which have been established are as follows:

1. Canada has immense iron ore deposits distributed at widely different points, as illustrated by the accompanying map. The deposits in Northern Ontario, in the Ottawa and Gatineau districts, and in Vancouver and Texada Islands are specially noteworthy.

2. Many of these ore deposits are situated in localities where coke for smelting operations has to be imported from Pennsylvania at prohibitive costs. In fact, it is only in the extreme eastern portion of Canada, where the iron ore of Newfoundland can be worked economically with the coal deposits of Cape Breton, that an extensive iron industry has developed. In On-

(16) R. 102, p. 11.

(17) See R. 24, pp. 383-93, for a description of plants and metallurgical processes for the production of the matte.

(18) C.I., p. 68.

(19) R. 16, pp. 93-5.

tario and British Columbia coke for metallurgical purposes has to be imported.

3. The deposits are, however, usually situated near some source of water-power that could be developed at low cost.

4. The experiments at Sault Ste. Marie have shown that by the electro-thermic process it is possible to smelt economically not only hematite ore, but also magnetite ores, which are the chief source of iron in this country. Furthermore, owing to the high temperature at which the reactions occur in the furnace and the consequent possibility of fusing highly basic slags, ores high in sulphur as well as titaniferous ores can be readily reduced in the electric furnace. The experiments also showed that in place of the expensive coke derived from Pennsylvania, peat coke as well as mill refuse and sawdust can be used.

While these facts have led to very optimistic views on the possibilities of developing a large Canadian iron industry by the use of electro-thermic processes, other considerations have also led investors to be rather conservative of embarking on ventures in this direction.

The most prominent fact about the iron and steel industry of the United States is its magnitude. The necessity for economy in even the smallest detail has led to colossal aggregations, in which every process has been devised by the most expert minds and carried out with the most improved machinery. To develop an industry in Canada which shall compete, for even the Canadian market, with the output of such plants, must require not only "a heavy initial expenditure in prospecting, securing and developing mines, timber lands, limestone quarries, railways, shipping docks, etc., necessary to secure a constant supply of the raw material," but also an extremely heavy outlay in the establishment of the plant itself, "an outlay which is much heavier in proportion to output than is required for the production of any other article of commerce."

Outside of the heavy investment necessary for economical running the nature and extent of the ore deposit itself is of prime importance. Before any development whatever can be considered, there must be a certainty that the deposit of ore is not only extensive but also suitable for metallurgical purposes. The lack of ores suitable for treatment by the blast furnace has, in fact, been one of the factors preventing the growth of an iron industry in Ontario. In this province there were smelted, during 1909, 543,000 tons of foreign (United States) ores, while 220,000 tons of domestic ores were treated.[20] Under the present conditions, the Ontario smelters have to pay a maximum figure for fuel, and are therefore naturally anxious to smelt only "those ores that yield an amount of merchantable pig iron sufficient to insure the operation of the furnace upon a profitable basis. If the smelter could secure a cheaper fuel, he could afford to smelt

(20) B.M.O., pp. 29-30, also p. 154.

leaner ores, but so long as he must pay between five and six dollars a ton for his coke, furnace economy requires an ore mixture yielding a maximum percentage of iron."

By the use of electro-thermic processes and some method of concentrating the ores, it is quite within the limits of possibility that a much larger iron industry could be developed in Ontario. Recent government experiments on low grade magnetite ores from different points in Ontario have demonstrated "that first class bessemer concentrates (with one exception) can be produced from the crude ores submitted for testing purposes, and it has been shown that all of these concentrates will form hard porous briquettes, more or less peroxidized and free from sulphur, when submitted to a process similar to the Grondal system of briquetting."[21] These briquettes could, of course, be treated in the electric furnace, thus cutting down on the necessity for using a high-priced fuel. The combination of concentration and electric furnace appears all the more advantageous when it is considered that Ontario contains numerous sources of power that could be developed at low cost.

Another factor which has so far hindered the development of iron smelting plants in certain localities is the lack of a sufficient market near at hand. An excellent illustration of this is furnished by the case of Vancouver and Texada Islands. These islands have abundant supplies of magnetite ore; the numerous inlets off the coast enable transportation costs to be reduced to a minimum,[22] but at the present time no iron ore is mined for two very good reasons—lack of cheap metallurgical coke and absence of a market close at hand.

In the electric furnace it would probably be possible to utilize the coal from Vancouver Island, of which there is an abundant supply. In a recent report on the iron ores of this region, Mr. Lindeman estimates that pig iron could be produced on the coast at about $16.00 per gross ton, as compared with a present cost to consumers of $22.00 to $31.00. "It would therefore appear," he writes, "that an iron industry on the coast of British Columbia should be fairly remunerative, provided that the province has a sufficient market to support such an industry. This is, however, not the case at present, the import of pig iron during the fiscal year ending March, 1908, being only 2,282 short tons.

"With such a limited home market, an iron industry would have to find a market for its surplus product outside the province. A large and growing market is certainly offered by the western United States, but the manufacturers of that country are protected by a customs duty of $4 per ton of pig iron. The rapid development of the western States seems to suggest that an iron industry on the Pacific coast of the United States, will

(21) B.M.O., p. 171.
(22) B.C., p. 24.

soon be established.[23] That such an industry, protected by the high import duty of $4 per ton on pig iron would be a dangerous competitor with a British Columbia blast furnace plant, in this American market, is apparent. On the other hand, it has often been suggested that the Orient would offer a great market. This is a question of the future, but as conditions are now, it seems impossible that a British Columbia smelting furnace, working with expensive labor and fuel, could compete with other iron producers of the world in this Oriental market.

"Though a profitable iron industry does not at present seem probable, there is room for confident anticipation, that, with the prospective rapid development of the province, the conditions will be more favorable in the future, and that it will then be practicable to turn to profitable account the iron ore resources on the coast of British Columbia."[24]

For a number of years the Canadian Government has attempted to encourage the development of an iron and steel industry in this country by subsidizing the manufacture of both products.[25] More recently bounties have also been established on iron and steel manufactured by the electro-thermic process. So far, however, the iron industry has not kept pace with other metallurgical developments. The total output of pig iron during 1910 was 800,797 tons, valued at $11,245,630. The total production of steel ingots and castings in the same year was approximately 822,881 tons.[26] Considering the fact that during 1910 there were imported only 158,910 tons of pig iron,[27] it appears as if at the present time the production of the country is almost keeping pace with the demand. With the growth in population there must, however, come a rapid increase in the number of engineering projects throughout the whole country, and, consequently, a much greater demand for iron and steel. Considering the advantages offered by electro-thermic processes and their special applicability to Canadian ores, there seems to be no doubt but that there is a promising future for the electric iron and steel industry in this country.

Zinc.—The zinc resources of British Columbia are considerable. In 1905 the Canadian Government appointed a commission to investigate the zinc resources of the province. As the report of this commission[28] contains complete information upon this subject, only a brief summary of the situation need be given in this connection.

Zinc occurs in British Columbia mainly as blende associated

(23) Since the above was written an electric iron plant has been established in California.

(24) Iron Ore Deposits of Vancouver and Texada Islands, p. 26.

(25) R. 24, pp. 310-11.

(26) R. 102, p. 13.

(27) Report of the Department of Trade and Commerce, 1910, pp. 48-9.

(28) See R. 12.

with argentiferous galena. While there are large deposits of fifty per cent. ores in the Slocan and Ainsworth mining districts,[29] there are also numerous deposits of ores which are poorer in zinc. "Until lately no account was taken at all of zinc contents in these ores, and a large amount of this very valuable metal was lost.[30] The attention of the Department of Mines has, however, been directed toward the problem of utilizing these ores commercially, and there is no doubt that in the near future some electrometallurgical process will be devised for recovering both the lead and zinc in these ores.

The question of treating the zinc ores of the Kootenay by some electric process has, indeed, received considerable attention during recent years. When it is remembered that the quantity of fuel required per ton of ore is greater in zinc smelting than in any other of the common metallurgical processes (about 1.75 tons of coal per ton of ore in the best practice),[31] it is readily seen that a process which substitutes power produced at low cost for a considerable portion of the expensive fuel, must appear desirable. It is worth noting that this factor of cost of coal influenced the Canada Metal Co., Ltd., to erect its smelter at Frank, Alberta, in the Crow's Nest Coal Field, just east of the British Columbia line.

In 1909 a Snyder zinc smelter was erected at Nelson, B.C., by the Canada Zinc Co. The intention was to treat mixed argentiferous zinc-lead ores, with a view to producing lead bullion and commercial spelter in one operation. So far, however, the plant has remained practically idle.

As already mentioned, the Department of Mines, at Ottawa, is interested in the problem of exploiting the ores of the Kootenay district, and an investigation is now being carried on by Dr. Stansfield, at McGill University, on characteristic ores of this district. According to the most recent information,[32] Dr. Haanel has announced "that if the preliminary research work indicated an electric process, the smelter built at Nelson by the Canada Zinc Company would almost certainly be used to complete the work, while, if some other process were indicated, the smelter would probably be located at Nelson in any event, for convenience to power and the ores."

The report from which the above is taken also contains the information that two private companies are conducting experiments with electric smelting of zinc ores of the Kootenay. It is, therefore, to be expected that some economical process will

(29) According to the Report of the Commission, p. 47, "15,000 tons of ore of 50 per cent. grade would be a liberal estimate for the annual productive capacity of the Slocan." The mine of the Ainsworth camp could, according to the estimate of the Commission, produce 16,000 to 30,000 tons per annum.

(30) C.I., p. 10

(31) R. 12, p. 51

(32) B.C., p. 103.

be devised in the near future for treating the zinc ores of British Columbia.

A rather interesting contribution to this subject has been made by Mr. Ingalls, in the report on the zinc resources of British Columbia,[33] to which reference has been made already. He writes as follows:

"It is unlikely that the electric smelting of zinc ore can ever be profitably carried on in the zinc producing districts of the East and West Kootenays, B.C., because in many parts of those districts the water-powers are small and irregular. . . . Where there are large water-powers, as for example, at Bonnington Falls, the power generated is so valuable for mining and miscellaneous purposes that it could not be furnished at the low figure which would be required by an electric smelting plant.

"On the coast of British Columbia, I am informed, there are many large water-powers, which can be developed at so comparatively small a cost as to permit them to furnish power at a low figure. It is possible that at some future date these may be utilized for the electric smelting of zinc and other ores. Possibly, also, water-powers in Eastern Canada may be similarly utilized. Any such development is, however, something of the future, and is not to be reckoned upon at the present time. Electric smelting of zinc ores must undoubtedly go through many stages of experiment before it can be pronounced a metallurgical and commercial success."

Coal.—The following table, taken from the report of the Conservation Commission,[34] gives some estimate of the coal resources of Canada:—

Province	Area of Coal Land (in square miles.)	Anthracite (in millions of tons.)	Bituminous (in millions of tons)	Lignite (in millions of tons.)	Total. (in millions of tons.)
Nova Scotia	992		6,250		6,250
New Brunswick	112		155		155
Manitoba	48			330	330
Saskatchewan	7,500			20,000	
Alberta	19,582	400	44,530	60,002	104,932
British Columbia ...	1,123	20	38,642	314	38,976
Yukon	400	32	32	850	914
Mackenzie Dist.	200			500	500

The coal of Nova Scotia, which is derived from the carboniferous formation, is bituminous, of good quality, well adapted to the production of coke, and excellent for domestic uses and for steam coal.

The most important coal areas of Canada are located in the western provinces, the coal being found in the Cretaceous formation. As shown in the table, these coals are mostly bituminous and lignite, the coke from which is not nearly as suitable for metallurgical purposes as Pennsylvania coke.

(33) R. 12, pp. 129-33.
(34) C.M., p. 430.

A noteworthy feature is the total absence of coal areas in the provinces of Quebec and Ontario. As, however, the latter of these provinces possesses large peat bogs, the attention of the Department of Mines has been directed in recent years towards the question of utilizing this source of fuel, and very favorable results have been obtained.[35]

It may be that, as a result of the experiments performed at Sault Ste. Marie, it will be possible to utilize this peat in electrometallurgical industries. In that case, Ontario iron smelters would no longer be compelled to import coke from Pennsylvania.

Miscellaneous Industries.—While in the above paragraphs the probable electrometallurgical developments in this country have been the subject of discussion, it must not be forgotten that there are opportunities in Canada for the growth of other electrochemical industries.

During 1910 Canada imported 682,816 dollars worth of nitrate of soda and over a half-million dollars' worth of other fertilizers. It is more than likely that with the growth of the farming industry of the country there must come a time in the near future when there will be a much greater demand for artificial fertilizers, and "seeing that this country is almost prodigally furnished by nature with water powers, from which electric energy can be developed at reasonable rates, there is no reason why a flourishing industry in the manufacture of air nitrates (similar to that of Norway) should not be established for supplying not only our own home market, but also the markets of the United States and the Orient."[36]

The production of different ferro-alloys also seems to offer an inviting field. There are numerous deposits of tungsten, chromium and manganese ores throughout the eastern provinces, and there is no doubt that the exploitation of some of these deposits would be found a profitable venture.

Water-Power Facilities.

A discussion of the future electrochemical developments of Canada would be incomplete without some mention of its water-power facilities.

A complete survey of the total available water-power resources of this country has yet to be made. Such a summary is promised by the Conservation Commission. A very fair idea, however, of these resources may be obtained from the reports of the Hydro-Electric Commission of Ontario and from the address delivered by Mr. Coutlee, the engineer of the Ottawa Storage Company at the first annual meeting of the Conservation Commission.[37]

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(35) See Report No. 71, Department of Mines, Ottawa.
(36) Summary Report of the Mines Branch, 1909 ,p. 7.
(37) C.I., p. 152.

In the province of British Columbia the total amount of power already developed and in process of development amounts to about 75,000 horse-power. It is impossible to state what amount of power can be obtained from the numerous water-powers off the coast, but they would certainly aggregate another 50,000 horse-power.

The Mackenzie basin presents few power possibilities, but the basin of Lake Winnipeg, with a drainage area of 350,000 square miles, "promises well for water-power when an increasing population provides the demand." Lake Winnipeg itself is an enormous reservoir 700 feet above Hudson's Bay, and it flows out through the Nelson River, which has exceptional opportunities for water-power. The rivers which empty into Lake Winnipeg also offer opportunities for water-power.

In Ontario the sources of water-power are almost innumerable. Nearly every village and town which is anywhere near a water-power has developed its own municipal light and power plant and holds forth enticing offers to the manufacturer who will locate in its boundaries. A very complete summary of the water-power available from the different divisions has been given by the Hydro Electric Commission of Ontario. From their reports, it is probably safe to estimate that the total available water-power of the province, excluding that available from Niagara Falls and the Soo rapids, is close unto a million horse-power.[38] The Ottawa River alone is capable of supplying over 300,000 horse-power, while the numerous falls on the Gatineau can supply over 200,000 horse-power.

In the province of Quebec, "the numerous tributaries of the St. Lawrence present remarkable power possibilities, as they flow in rock basins with many abrupt falls." Montreal, Quebec, Three Rivers, and other cities along the St. Lawrence, are supplied with light and power by hydro-electric plants.

New Brunswick also possesses several rivers with exceptional power possibilities. "At the present time only the St. John River has been exploited. The Grand Forks Power Company is building a plant at that place to develop 80,000 horse-power. This will be used for the manufacture of pulp and for the municipal supplies of Woodstock, Fredericton and St. John."

This brief summary will probably serve to convey some idea of the numerous water-power facilities of this country. Canada is at present in the happy position of possessing in these water-powers a source of wealth which has not been monopolized to any extent, and in view of the policy adopted by the legislature of Ontario, as well as other provincial legislatures, it is certain that such a national heritage will be entrusted to the care of none but those who will utilize it for the people under terms to be defined by the people.

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(38) This estimate has been obtained by adding the figures given in the reports for the individual water-powers.

Transportation Facilities.

Next to the subject of power development that of transportation facilities is of greatest interest to the industrial chemist and metallurgist.

The history of railway development in Canada is one of the most remarkable features of Canadian history. When it is remembered that in the year of Confederation (1867) Canada possessed only 2,278 miles of railroad, while at the present time it indulges in the possession of a railroad mileage which is close unto 25,000; when it is remembered that the Canadian Pacific Railway was only completed in 1886, just twenty-five years ago, after the Government had granted the company 62 millions in cash and construction and 25 million acres of land, while at the present time there are in operation two more transcontinental railways; when these facts are considered well, it is apparent that the railway facilities of this country have been increased at an enormous rate during the past two decades. The various branches of these three great railways penetrate forests which five years ago had rarely felt the tread of a white man: the periodical arrival and departure of trains has become an unnoticed phenomenon in towns which have risen at the command of some modern Aladdin, as it were, in regions which not more than five years ago were as far removed from civilization as Toronto is from New York.

This completes, in a sense, the discussion of the possibilities in electrochemical and electrometallurgical possibilities which Canada offers. While time and space have necessarily forbidden me to dilate to any extent on any one topic, I trust that some idea at least has been conveyed of the faith which a great many individuals have in the future of this country.

We have crossed and re-crossed in magnificent leaps of 3,000 miles the vast region comprised under the name of the Dominion of Canada. From Ungava to the Yukon, from the smiling fruitland of the Niagara peninsula to the vast Cordilleran ranges, there stretches a country which possesses resources and wealth such as few can conceive.

This land, endowed with a mineral wealth beyond the wildest dreams of the present generation, this land, upon which has been bestowed in profusion all the advantages which go towards the forming of a great commercial nation, looks forward to the twentieth century as its very own. The nineteenth century has seen the growth of a wonderful nation in one-half of the North American continent, the twentieth century will see the equally remarkable rise of a twin-nation in the other half of this continent.

In this great evolution which must occur in the next decade, the electrochemical engineer will be called upon to solve many problems, not the least important of which will be that of utilizing the natural resources of this country in the most econ-

omical manner possible, and upon this task h will have to concentrate all his knowledge and wisest judgment. Let us hope then that he will not be found wanting at this great opportunity.

Abbreviations.

C.I.—First Annual Report of Commission of Conservation, Ottawa, 1910.

C.M.—Report of Commission of Conservation on Lands, Fisheries and Game, Minerals, Ottawa, 1911.

R. 12—Report of the Commission appointed to investigate the Zinc Resources of British Columbia and the Conditions affecting their Exploitation, W. R. Ingalls, 1905. Report No. 12, Department of Mines, Ottawa.

R. 16—Report on the Experiments made at Sault Ste. Marie, under Government auspices, in the smelting of Canadian ores by the electrothermic process. Report No. 16, Department of Mines, Ottawa.

R. 24—General Report on the Mining and Metallurgical Industries of Canada, 1907-8. Report No. 24, Department of Mines, Ottawa.

R. 88—Annual Report on the Mineral Production of Canada, 1909. Report No. 88, Department of Mines, Ottawa.

R. 102—Preliminary Report on the Mineral Production of Canada, 1910. Report No. 102, Department of Mines, Ottawa.

B.M.O.—Report of the Bureau of Mines, Ontario, 1910, Part I.

B.C.—Report of the Bureau of Mines, British Columbia, 1910.

STEAM CONDENSING EQUIPMENTS.*

A. G. CHRISTIE, '01.

Asst. Professor of Steam Engineering, University of Wisconsin.

It is a matter of general knowledge that the atmosphere surrounding the earth consists of a mixture of gases, principally of oxygen and nitrogen, and that this atmosphere extends to a sufficient height above the earth's surface to produce a pressure at sea level of 14.7 pounds per square inch absolute. For ordinary purposes of life this pressure is not objectionable, but in certain phases of engineering, especially when steam is used, this pressure is detrimental and steps have to be taken to reduce it. It is usually desired to make this reduction of pressure in a closed chamber, such as an engine or turbine cylinder. Such a reduction of pressure, in ordinary engineering terms, is known as "producing a vacuum." Hence we can define a vacuum as a reduction of the pressure in a chamber below that of the surrounding atmosphere.

The equipment to produce a vacuum in steam engines is known as the condensing outfit and consists of the condenser and its accompanying pumps.

The pressure of the atmosphere is usually measured on a barometer, which indicates this air pressure by the height in inches of a column of mercury. Hence 14.7 pounds per square inch absolute corresponds to a barometer of 29.97 inches of

*Read before the Engineering Society, Nov. 30, 1911.

mercury, which is usually spoken of as a 30-inch barometer. Now, if the air pressure in a closed chamber is reduced below that of the surrounding atmosphere, and if this chamber is connected to one end of a glass tube, the lower end of which is placed in a bath of mercury, then the atmosphere will force the mercury up the tube until the height of the mercury column equals the difference in pressure between the inside of the chamber and the atmosphere. Thus we have the common means of measuring vacuum by the height of a column of mercury in inches equal to the differences of pressure on the inside and outside of an engine exhaust. Hence one hears an engineer remark that he carries 28 inches of vacuum on his turbine exhaust.

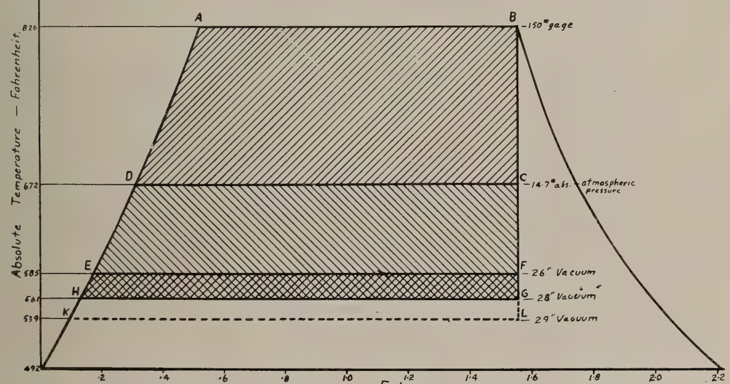
One of the advantages to be gained by producing a vacuum in an engine exhaust is the increased energy made available by the expansion of the steam, and, consequently, the more useful work each pound of steam will produce in the engine. This can be shown very clearly in Fig. 1, which shows on a temperature entropy diagram the ideal or adiabatic expansion of one pound of dry steam from 150 pounds pressure above atmosphere to a pressure of 1 pound per square inch. Without entering into a discussion of the construction or meaning of this diagram, it will be sufficient to say that the area ABCD is proportional to the energy available for work when steam expands without external losses from 150 pounds per square inch above the atmosphere to atmospheric pressure. The area ADFE is proportional to the energy available for work when the expansion is carried further from atmospheric pressure to a pressure corresponding to a 26 in. vacuum, as is usual with a steam engine, while the area ADGH represents the corresponding energy with a 28 in. vacuum, as used on steam turbines. A glance will show that the energy available for work by expanding the steam from atmospheric pressure into a 28 in. vacuum is almost equal to the energy available by expanding the steam from 150 pounds per square inch to atmospheric pressure. It is, therefore, obvious that a suitable engine operating with 28 inches of vacuum should produce about twice as much work per pound of steam used as an engine with no vacuum at all, or, conversely, the former should use just half as much steam as the latter for the same work. A reduction in steam consumption brings about a corresponding reduction in the amount of coal burned, and hence a decrease in the cost of power.

All water used for commercial purposes contains a small amount of air in solution, usually taken as 5 p.c. When this water is pumped into a boiler it carries some air with it in solution. After it has been evaporated into steam, the mixture of air and vapor passes over to the engine and out the exhaust. If the expansion of steam is carried below atmospheric pressure to a vacuum at exhaust, there will be a tendency for the atmospheric pressure to force air in through stuffing boxes, packing,

or any other possible opening. When air leaks into a vacuum in such a manner its volume is increased many times.

The exhaust from an engine is then a mixture of air and steam vapor, and, in order to maintain the vacuum desired, this must be at once removed. The steam may be converted into water again by removing its latent heat by means of some cooling medium, usually cold water from another source of supply. Hence we have arrangements in condensers whereby cold water is either brought into contact with the exhaust steam itself or is circulated on the inside of metal tubes, which are surrounded on the outside by the steam. These are the two fundamental types

FIG. 1
TEMPERATURE — ENTROPY DIAGRAM
SHOWING
ADIABATIC EXPANSION FROM 164·7# ABSOLUTE.



of condensers. The former is known as the jet condenser, while the latter is called the surface condenser. In jet condensers, the water is often forced into the vacuum of the condensing chamber by the pressure of the atmosphere. But for all other purposes a means must be provided to circulate the required amount of cooling water, and what is known as a circulating pump is usually used for this purpose.

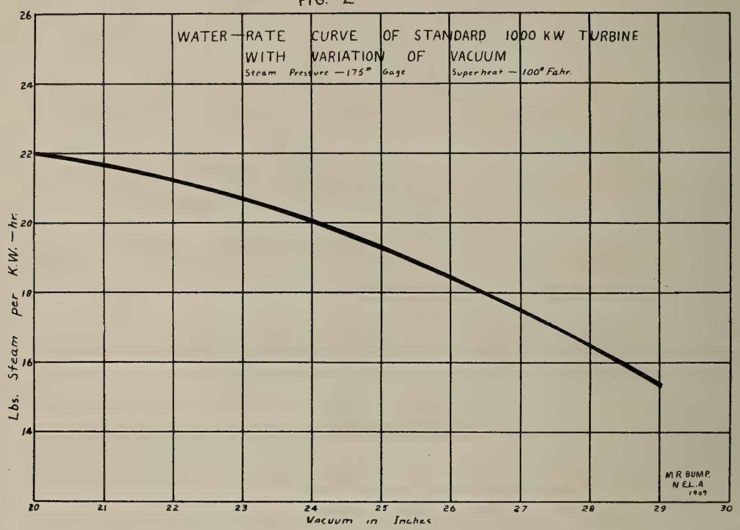
The air, which has been carried along with the steam must also be removed if a vacuum is to be maintained in the condenser. It cannot be condensed, and hence must be pumped out by some means as fast as it enters. The form of air compressor used for this work is known as an air pump. Hence we have as our essentials to maintain a vacuum a condenser, its circulating pump and its air pump.

Referring again to Fig. 1, it would seem that the higher the

vacuum the greater would be the energy available and the more efficient the engine would become in its use of steam. The limitations of the cylinder sizes and other factors in reciprocating engines are such that usually no further expansion is profitable beyond 26 inches of vacuum. But there is no limit in steam turbines to the vacuum which may be carried if the blading is suitably designed. Fig. 2 shows the decrease in steam consumption of a steam turbine as the vacuum increases, as found by actual test.

The cooling water leaving the condenser cannot be hotter than the steam temperature corresponding to the degree of vacuum, and, in many condensers, is usually 10°F. below this

FIG. 2



temperature. The temperature of steam with 26 inches vacuum is 125°F., with 28 inches vacuum 101°F., while with 29 inches of vacuum it is only 80°F. The corresponding outlet water temperatures allowing 10°F. drop as above would be 115°F., 91°F. and 70°F., respectively. If the average temperature of the water supply is 55°F., then each pound of cooling water will carry away 60 B.T.U., 36 B.T.U., and 15 B.T.U. in the three cases. The heat to be removed from the steam to condense it for approximation can be said to remain constant in all three cases, so that the quantity of cooling water to condense the same weight of steam in the three cases will be about as 1:1.66:4. As it takes power to pump this water, it can be seen at once why it costs more to maintain the higher vacuums.

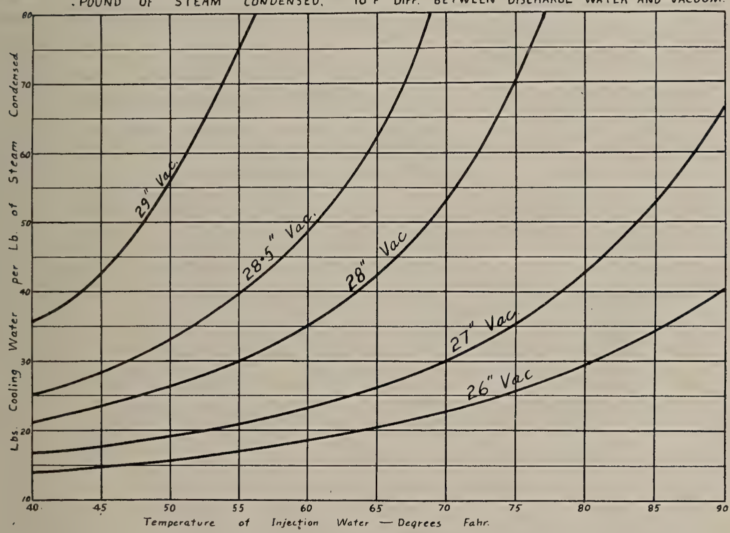
Fig. 3 shows the actual amount of circulating water required in practice for different vacua. For high vacuum there must be a much greater supply of cold water than for a low vacuum.

Now the volume of the air increases rapidly with the higher vacua and hence the volume of the pump cylinder must be increased to provide for it. More power will be required to compress this air to atmospheric pressure. Consequently an increase in vacuum means a corresponding increase in operation costs on the air pump.

The condensation problem then resolves itself into an equation of costs. If the water supply is limited, then the vacuum that may be carried will be fixed by this consideration. But if there is ample cold water, then one must determine when the saving in fuel costs, due to decreased steam consumption on the main engine, equals the increased operating costs of pumping cooling water and removing air together with the upkeep, interest and depreciation of this larger and more expensive appar-

FIG. 3.

CURVES SHOWING THEORETICAL COOLING WATER REQUIRED PER POUND OF STEAM CONDENSED. 10°F DIFF. BETWEEN DISCHARGE WATER AND VACUUM.



atus. Usually the limiting factor is the amount of air leakage into the engine cylinder, the exhaust line, and the condenser, and every step should be taken to reduce this to a minimum.

A treatment of the economics of such an engineering problem, while of very great practical interest, is beyond the limits of this discussion, and the remainder of the article will deal with present day commercial forms of condensing equipment.

Some engineers hold that it is not possible to maintain as relatively high a vacuum at a high altitude, like that of Calgary, Alberta, as near sea level. Now, the absolute pressure in a condenser is equal to the difference between the vacuum and the barometric pressure, and this can be maintained constantly irre-

spective of altitude with any given equipment. Moreover, it can be shown that not only is it possible to hold as good an absolute vacuum at the high level, but the power to drive auxiliaries is decreased to a considerable extent at the same time. Hence the cost of producing the same relative vacuum remains constant or decreases slightly as the altitude increases.

The essential requirements of a condensing plant may be stated as follows: Sufficient cooling water must be supplied to provide the necessary vacuum; there must be a rapid transfer of heat from the steam to the cooling water in order to produce

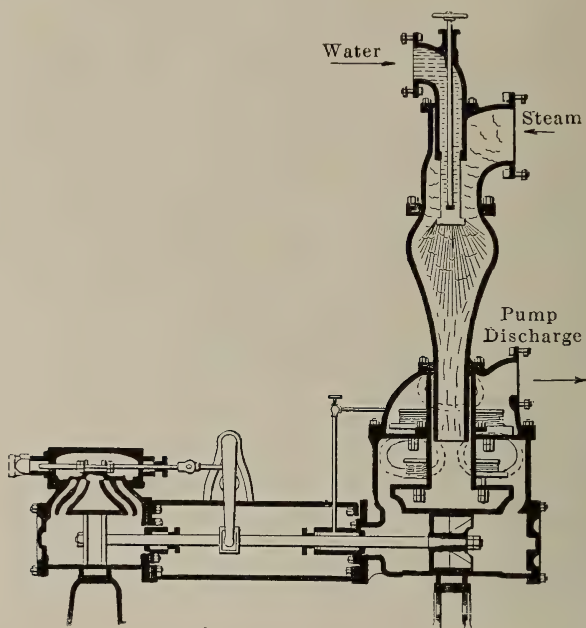


Fig. 4
Jet Condenser.

quick condensation; and the accompanying air must be removed with the least expenditure of power.

In commercial practice there are three simple types of condenser used to provide vacua up to 26 inches, such as are required in steam engine work.

The simplest of these is the ordinary jet condenser shown in Fig. 4. This consists of a vacuum chamber, in which the cooling water and steam are brought into intimate contact, and after condensation all water and the accompanying air are removed by a piston pump attached to the bottom of the condenser. In the usual designs of this type there is seldom an intimate mixture of water and steam, and hence more water is required than

should be necessary. But even under these conditions the amount of cooling water is often much less than that required by ordinary surface condensers. The equipment is cheap in first cost and occupies very little space. As the cooling water carries air in solution, air pumps of large capacity are required with consequent large power expenditure. There is also the disadvantage that the condenser discharge cannot be used to feed boilers unless the cooling water is unusually pure and free from acids or alkalis. Unless care is taken in operation there is also the possibility of water being drawn over into the low pressure cylinder of the engine should the load go off suddenly. Such an occurrence usually wrecks the engine. Improvements, which will be referred to later, have recently been made on this type to adapt it to the requirements of high vacuum work, so that it is still one of the most important types of condensers.

The barometric condenser is a modification of the simple jet. The cooling water and steam are led in separate pipes to an elevated condenser head at least 34 feet above the level of the hot-well, where the two are mixed. The resulting mass of water all passes out through a tail pipe, which is submerged in the hot well. The air present in the condenser is entrained by various methods as the water leaves the head, and is thus carried away at the same time. This condenser arrangement costs more than the simple jet to install, but is very cheap to operate. If near the cooling water supply the head to be lifted against by the circulating pump is equal only to the difference between the height from supply level to condenser head and the equivalent head of vacuum. A vacuum of 26 inches can be easily maintained in most condensers without an air pump. There is no possibility of flooding engine cylinders with this arrangement of piping. The condenser head can be so arranged that the mixing of water and steam is very intimate, and thus the least amount of water can be used to maintain a given vacuum. This type of condenser is especially adapted for using very foul water, and if the pump and condenser are lead lined, it can be even used with acid mine water.

A typical surface condenser for steam engine work is shown in Fig. 5. It consists of a closed vessel, usually of cast iron, of either circular or rectangular section, into which the exhaust steam is led. This chamber is traversed by a large number of thin brass tubes, through which water is circulated. The steam strikes these cold tubes, condenses, and falls to the bottom of the shell. The air being heavier than the steam, also collects in the bottom, and these together are removed by the wet air pump. This pump is driven by a small steam cylinder. The pump for circulating the cooling water is placed on the other end of the common piston rod. The cooling water and condensed steam do not mix, and hence the latter is pure distilled water, which can therefore be fed directly into the boilers, provided it is not rendered useless by the presence of too much cylinder oil. Water

absolutely unfit for boiler feed may be used for cooling, and thus we find that in marine work the surface condenser is used almost exclusively. As there must necessarily be a difference in temperature between the cooling water and the steam in order that heat may flow through the metal tube, a greater amount of cooling water will be required with this type of condenser than with either of the preceding types. The first cost of this equipment is high and its repair charges are also high. Since the amount of air to be removed is relatively small as compared with the jet or barometric condenser, its air pump is also small, and hence its operating costs are low.

In surface condensers the cooling water is usually arranged to enter the lower tubes and leave from the upper tubes, so that

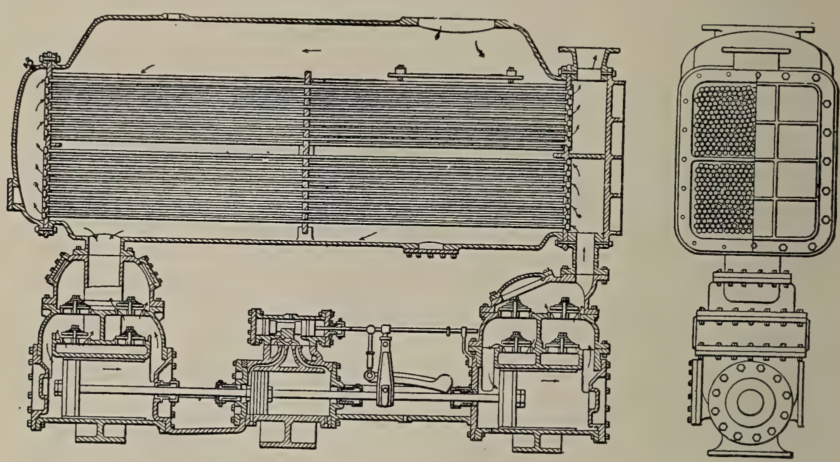


Fig. 5.

Surface Condenser.

each tube is filled with water irrespective of the amount circulated.

The condensers dealt with so far have been those intended for use with reciprocating engines. At the present time, however, steam turbines are invariably installed for most purposes where the power exceeds 400 h.p. in one unit. In steam turbines, as already pointed out, the maintenance of high vacuum results in improved operating economy. Therefore the condensing equipment chosen for use with steam turbines should aim to provide the highest vacuum possible under the conditions of operation.

A number of considerations should enter into the selection of the type of condenser for high vacuum. The amount and average temperature of the cooling water may place limitations

on the vacuum to be obtained. Its quality and its suitability for boiler feed purposes are factors which influence largely the selection of the type of condenser. It has been the experience of the writer that power plant designers very frequently overlook the adaptability of the water supply to boiler feed purposes. Barometric condensers have been installed where the water supply, on account of the scale-forming substances held in solution, was absolutely unfit for feeding into boilers. At other times surface condensers have been installed where the water was quite soft and where a cheaper equipment could have been easily justified. This is a very important consideration and should receive most careful attention, if the operating costs are not to be excessive.

To obtain high vacuum there must be sufficient cooling water for the type of condenser selected. This condenser must be of such construction as to provide a rapid transmission of heat from the steam to the cooling water. Air pumps are always used for high vacuum, and these must be of ample capacity to remove the mixture of air and water vapor, which is always present under these conditions. In order to make the capacity of this air pump as small as possible the air should be removed from the condenser at a point where it will be coldest, and hence occupies the least volume.

In the modern high vacuum surface condenser the cooling water is forced through the tubes at a high velocity, usually by a centrifugal pump, either motor or engine driven. The tubes are of brass and as thin as permissible for the service. These must frequently be cleaned of foreign material, which is carried in by the cooling water. The size of shell and the arrangement of tubes and baffling is such that the steam is directed against the tubes at a high velocity, thus insuring a very rapid transmission of heat and quick condensation. It has been noted that when the condensed steam from one tube is allowed to drip over all those below it, this film of water impairs the cooling qualities of each tube it passes over. Hence baffles are provided at intervals to carry the condensed steam to the sides of the shell. The circulating water, which makes three or more passes through the condenser, enters the bottom tubes first. Since the water in this portion is coldest, a certain number of tubes in the bottom are protected by a baffle from direct contact with the entering steam. The air is led through these tubes and cooled on its way to the pump suction.

Hon. C. A. Parsons introduced an additional feature shown in Fig. 6 to improve the efficiency of his surface condensers. It is known as a vacuum augmentor, and consists of a small steam jet placed in the throat of an ejector nozzle, which produces an additional vacuum to that of the pump and thus draws out the air from the main condenser and slightly compresses it. This mixed air and steam is passed through an auxiliary cooler, where the steam condenses. The air is next removed by the wet

air pump, which has much less volumetric capacity than would otherwise be required. The hot well pipe is provided with a water leg, as shown, to prevent the air leaking back into the condenser. It is said that this jet does not take more than 1½ p.c. of the steam of the main turbine and increases the vacuum about 1 inch.

In a condenser complete with its air and circulating water pumps the ends of both suction and discharge piping for the cooling water are usually submerged. Hence the circulating pump has only to overcome the friction head of the piping after water has started to flow through the condenser, provided the equipment is not placed too high above the source of supply.

The surface condenser thus provides a high vacuum at a low operating cost. The condensed steam from the turbines can pass

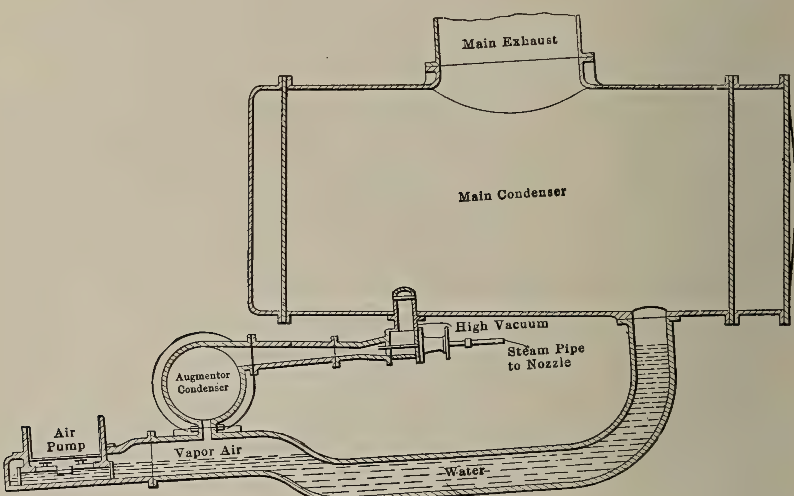


Fig. 6.

Parson's Augmentor Condenser.

directly back into the boilers. The condenser is fairly reliable in operation. Its first cost is high, and it occupies considerable space. It requires a large quantity of cooling water and must be frequently cleaned.

Fig. 7 shows an Alberger barometric condenser for steam turbine work. The water is sprayed over the chamber by a distributing cone, which is regulated automatically by the amount of water supplied, which acts against a light spring. A small pipe carries a portion of the cooling water into a chamber at the top in order to thoroughly cool the air which passes up through the hollow stem of the spray nozzle. The air pump suction is thus taken off from the coldest point. The water is thoroughly mixed with the steam before passing down into the tail-pipe. A certain amount of air is carried down the tail-pipe with the water,

so that in case the air pump is shut down it is still possible to operate with a small vacuum. The circulating pumps can be installed in duplicate, thus insuring against breakdown.

The cooling water is usually supplied by a centrifugal pump driven by a motor, a steam turbine, or a single engine, as conditions may require. Some manufacturers provide a so-called entrainer on the exhaust pipe. This pocket partially fills with water until the velocity of the steam is such that any further

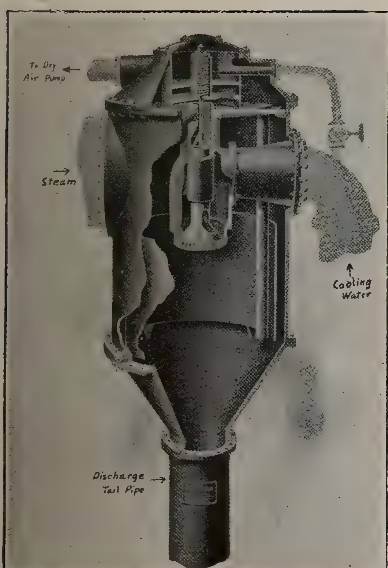


Fig. 7.
Alberger Barometric Condenser.

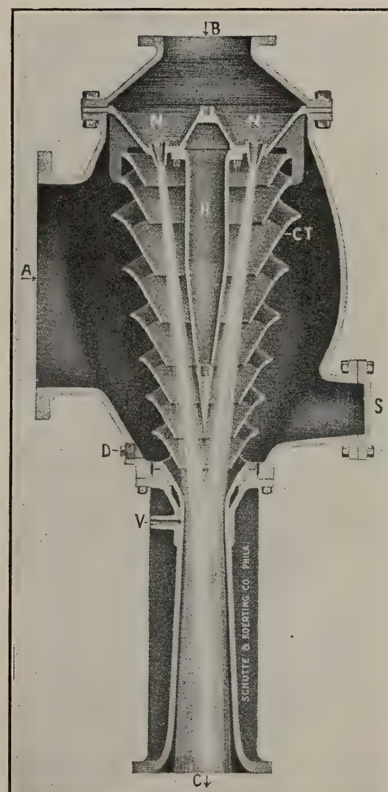


Fig. 8.
Koerting Ejector Condenser.

supply of water is carried along by the steam into the condenser. In order to obtain this high steam velocity there must be a marked difference of pressure between the turbine exhaust and the condenser head, which is most undesirable. If it is necessary to remove condensation from an exhaust pipe, it is best to provide a drip pocket in the pipe just before it rises to the condenser, and connect this pocket to a receiver and float controlled duplex pump or a motor-driven centrifugal pump. Such

a pump will readily remove all condensation. This arrangement causes no obstruction in the path of the exhaust steam.

There is practically nothing that can go wrong with a barometric condenser, and as it is impossible to flood the turbine with cooling water, it is the most reliable of all types. Since the water and steam mix very intimately, it will provide the highest degree of vacuum with the least amount of water, and is hence especially adaptable to places where the water supply is small or at a high temperature. It occupies little floor space, and its upkeep is small. The air pump, however, must deal with greater quantities of air and vapor than in the case of the surface condenser, and hence must be larger and more expensive. The circulating pump for the cooling water has to lift a smaller quantity of cooling water against a greater head and hence may be slightly more expensive to operate than in the case of the surface condenser. The first cost of the equipment, however, is about two-thirds of that of a surface condenser, piping included. The condenser discharge is not always suitable for boiler feed purposes.

Another similar type of condenser is the Koerting ejector condenser, shown in Fig. 8. Water is supplied by a circulating pump at a head equivalent to 20 feet of height. This water discharges through specially arranged nozzles into an ejector throat which forms the condensing chamber. The resulting condensed steam and any air present are carried along by the velocity of the water and discharged through the tail-pipe below. These condensers are cheap in first cost, as no air pump is required, and with sufficient cool water will be guaranteed to maintain 28 in. vacuum. Operating costs, when the load is variable, is higher than with a barometric condenser, as the same quantity of water must be pumped at all times, and as this water is under pressure there is also the danger of it entering the engine. The condenser will not work well with warm cooling water. The nozzles are easily stopped up by foreign substances if the water is dirty, and this would tend to destroy the vacuum.

The advent of the steam turbine has probably brought about greater improvements in jet condensers than in any other type. These condensers are frequently used on account of low first cost, of small floor space, and of small amount of cooling water necessary. But the condenser discharge is not always suitable for boiler feed purposes. Reciprocating air pumps have to be large to maintain high vacuum, but simple rotary pumps will be described later, which have proven very satisfactory and economical. There is also the possibility of flooding the turbine with water with these condensers, and each type is provided with some automatic vacuum breaker to prevent this. A few of these new condensers will be described.

Alberger's jet condenser is almost identical with their barometric condenser, except that it is placed at a low level, and the water is forced in by atmospheric pressure. Its tail-pipe has

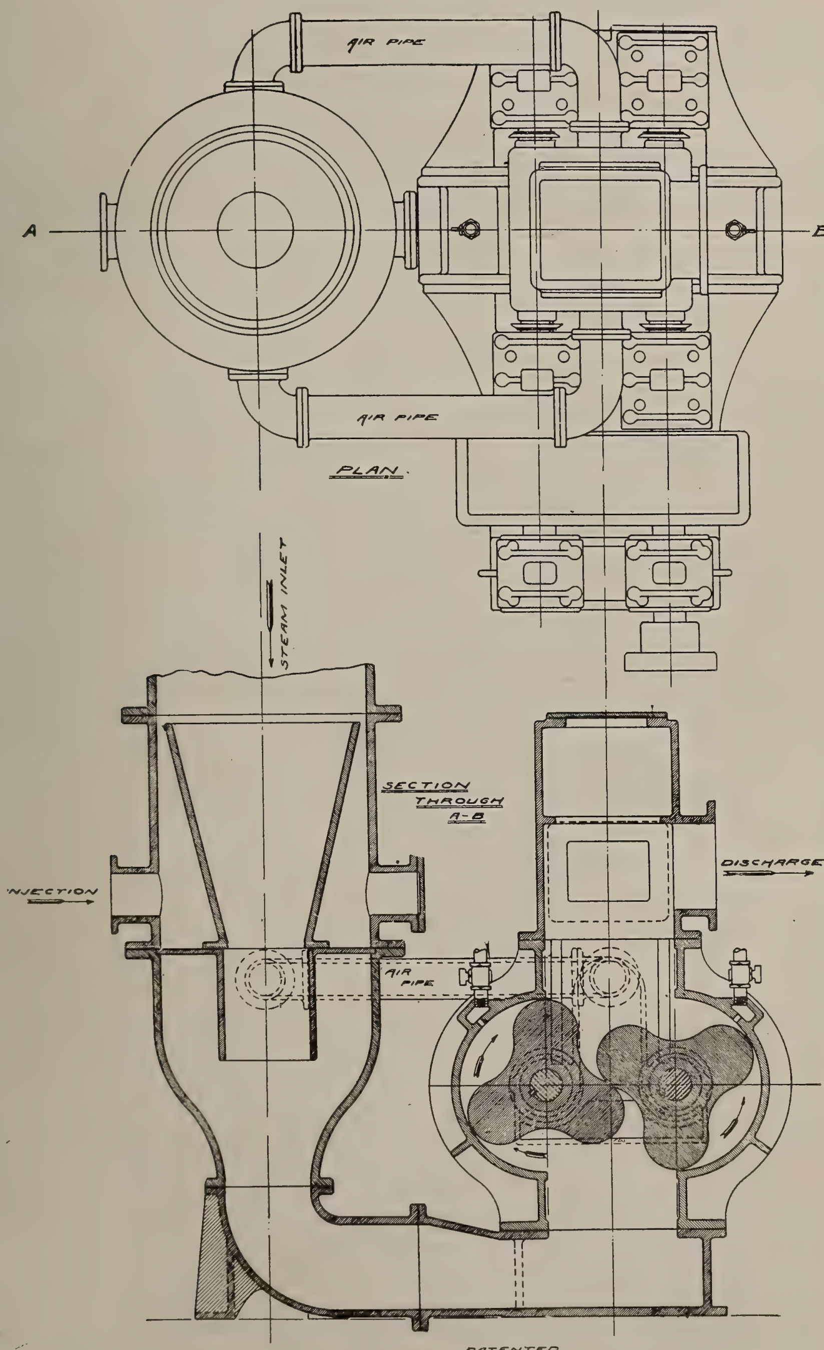


Fig. 9. Connorsville Jet Condenser.

been replaced by a centrifugal pump which discharges both the cooling water and the condensed steam. The air is removed by a standard dry air pump.

Fig. 9 shows a condenser manufactured by the Connorsville Blower Company. The pressure of the atmosphere forces the water into a reservoir in the condenser shell, from which it flows in a thin sheet down the funnel-shaped condensing chamber. The steam enters this chamber from above at high velocity. The velocity of the condensing steam is transferred to the water, which rushes through the throat of the funnel, carrying the air along with it and completing the condensation. The air rises in the chamber around the throat piece, and is cooled by the large body of cold water above it. The cooling water and condensed steam pass to the air pump. This pump is also connected to the air chamber by pipes, and ports are provided in the air pump casing, so that this air enters directly above the water and passes into the space between impellers just before the water is picked up. The pump itself is of the rotary cycloidal impeller type and works on the displacement principle. The clearances between the tips of the impellers and the casings and between the impellers themselves are small, and practically no leakage results, as these are water-sealed, as are also the stuffing boxes. The two impellers are geared together at one end of the shaft and may be either engine or motor driven. Two small cocks are placed on the casing above the impellers, to break the vacuum before opening to discharge. This makes the pump very smooth running.

This is a cheap and very good equipment for water which will not corrode iron. It is also quite economical in the power required to operate it, and has given good satisfaction in a large number of turbine plants where it has been installed.

The shell of the Allis-Chalmers Type C jet condenser is circular in shape, and is erected in a horizontal position. The main idea of the designers was to produce a "rain-storm" effect in the condenser, so that each particle of cooling water, by being brought into intimate contact with the steam, would absorb the maximum amount of heat possible. Hence very little more water need be supplied than that theoretically necessary to condense the steam. The water enters at one end and passes into castiron troughs, from which it overflows through saw-tooth openings. The steam enters at high velocity from the top of the other end and starts to condense on meeting the cooling water. The water then strikes the spray plates below, from which it splashes in all directions, and condensation is completed. The entrained air rises through the water in the left hand portion of the condenser and thus is cooled on its way to the air ejectors. The water overflows at the bottom of the condenser to a centrifugal pump, which forces it out into the waste channel. A second small centrifugal pump, which takes water from the cold well, is mounted on the same shaft as the cooling water dis-

charge pump. This cold water is forced under pressure into an air ejector nozzle, which forms the air pump for maintaining the vacuum. The end of this air ejector pipe is not submerged,

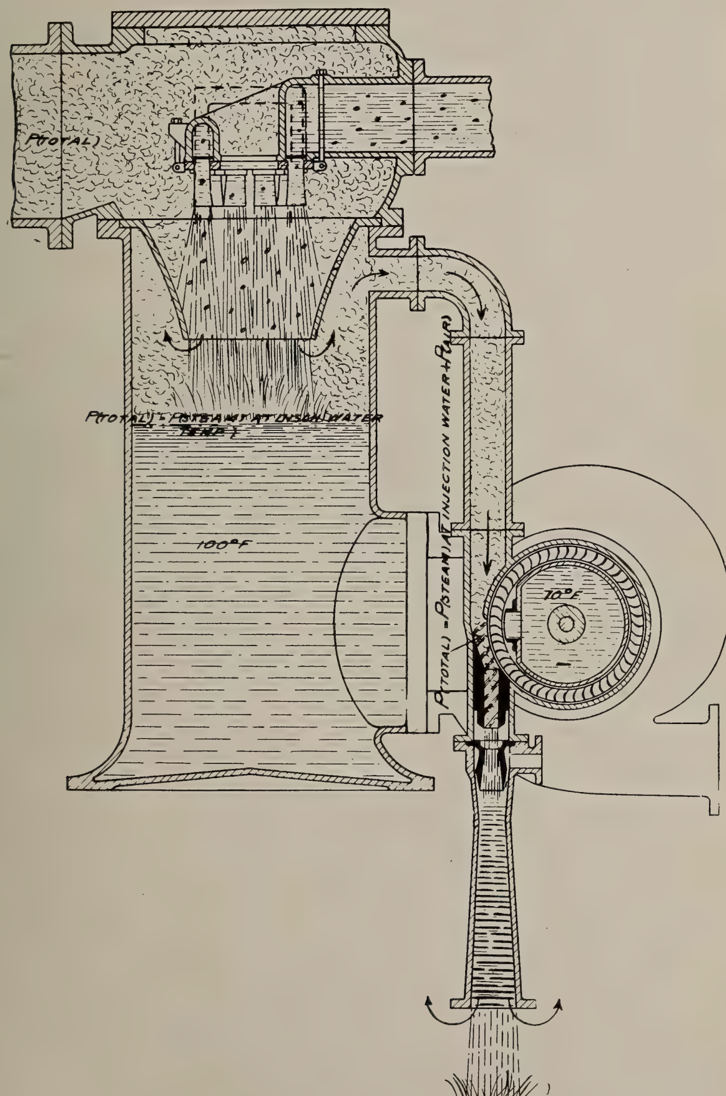


Fig. 10.
Leblanc Condenser.

so that in case of the pump stopping, air rushes in and breaks the vacuum before flooding of the turbine can occur. These pumps may be motor-driven, or may be turbine-driven, which is

the more usual arrangement. This condenser is very efficient in its use of water, but the method of pumping air requires considerable power. A similar method of removing air is used by Brown-Boveri and others in Europe.

The Leblanc condenser, manufactured by the Westinghouse Machine Co., is one of the simplest and most compact units at present built. As usually constructed, the water discharge pump and air pump casings are made part of the same casting as the condenser body itself.

Fig. 10 shows the general arrangement of parts. Steam enters on the left hand side of the condenser head, while cooling water rushes in from the right hand side. The water is sprayed by a distribution head in such a way that it mixes thoroughly with the steam. The discharge centrifugal pump in the base removes this water and condensed steam from the chamber. The air rises into the annular space around the condensing cone and is carried to the Leblanc air pump through the pipe shown. This pump, shown in Fig. 21, is on a new principle. Water enters at the center of the wheel and passes out through the chamber to the rotor. The rotor is provided with a large number of small crescent-shaped bronze blades, somewhat resembling a Sirocco blower. It revolves at high speed and acts like a centrifugal pump, apparently discharging the water delivered from the central chamber in thin solid sheets like so many panes of glass one behind the other with the air trapped between these sheets. In practice this ideal is scarcely realized in full, as the lower sheets of water are disturbed by the splashing of the upper ones on the sides of the air pipe. Whatever the action is inside the pump, the air is very effectually removed, and a high vacuum can be maintained with a total expenditure of power for condenser purposes of about 3 p.c. of that of the main turbine. The pumps may be either turbine or motor-driven.

Dry air pumps play a very important part in the maintenance of high vacua. Fig. 11 shows a section of an Alberger dry vacuum pump, which will illustrate the general principles of reciprocating pump construction. The cylinder is water-jacketed throughout to prevent undue heating in compression and to provide a large volumetric efficiency. The air valve is of the rotary type with ordinary pot discharge valves. The air and vapor enter one side of the piston on one stroke and are compressed and discharged on the return stroke. The valve gear is so arranged that when the piston is at dead center and about to return, a small port connects the two ends of the cylinder. Since the admission has just been cut off from one end, this port allows the highly compressed air in the clearance of the other end to rush over and to partially compress the air which has just entered. In this way the volumetric efficiency of the pump is greatly increased. Mr. F. H. Moody has discussed "Rotative Dry Vacuum Pumps" very fully in Vol. 3 of Applied Science, and no further discussion will be given here except to refer to

two types which are so very widely used as to deserve especial attention.

One of these, the Mullan Suction Valveless Air Pump, is manufactured by the Wheeler Condenser and Engineering Co. The cylinder is long and the piston fills almost half the cylinder volume. The air and vapor to be removed rush in when the piston uncovers the port in the middle and are compressed and discharged through the valves in the head on the return stroke. This pump is not provided with the by-pass port described with the Alberger pump.

The other type is known as the "Edwards," which is a vertical wet air pump, and is particularly adapted for working at

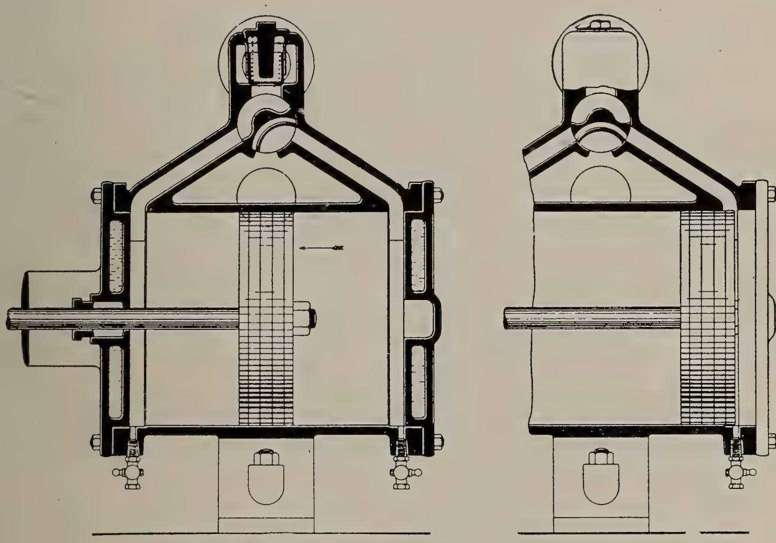


Fig. 11.

Alberger Dry Vacuum Pump.

high speeds. The piston, which is solid and has a cone-shaped bottom, descends to the bottom of the cylinder, which is of similar cone shape. The casing is so designed that the air and condensed steam are driven through ports into the space above the piston. On the return stroke water and air are forced out through the discharge valves in the deck at the head of the cylinder. As the water lies directly above the piston, it fills all clearance spaces before being forced through the valves and acts as a water seal of three to four inches deep on the valve above, very high vacua can be maintained by this type of pump. In Great Britain these pumps are almost invariably used with surface condensers. They are usually built with three cylinders worked from a three-throw crank shaft and motor-driven through

gearing. An Edwards pump must be placed at a lower level than the main condenser.

In Germany and other parts of the Continent rotary air pumps are being introduced very largely. There are many excellent types of these pumps, but only one will be described. This pump is manufactured by Thyssen. It is essentially a centrifugal pump with full discharge all around the periphery. The discharge from the pump impeller enters a stationary diffuser nozzle, which, in turn, discharges into an air ejector chamber. This pump has proven very satisfactory and quite economical. The A. E. G. air pump is also used extensively. It is quite probable that many of these rotary air pumps will soon be introduced into America, largely on account of their simplicity, freedom from breakdown, low first cost, small size, and ease in operation.

In Europe motor-driven condenser auxiliaries are generally installed, while in America these are steam-driven. If steam is needed to heat the feed water, or if absolute reliability is required, steam-driven pumps should be used. But in other situations, motor-driven auxiliaries may be used. It must be remembered, however, that should the main switches open from a short circuit on the electrical system, the condensing plant will shut down, and all these motors must be started individually before the load can be put on the main engine again. Motors will give trouble if installed in the wet or damp basements provided with poor ventilation and in which condensers are often located.

In conclusion, then, the selection of a condenser should be governed by:

1. The degree of vacuum required.
2. The quantity, quality, and temperature of the cooling water.
3. The requirements of boiler feed.
4. And, most important of all, the first cost and total operating costs of the equipment.

STREET PLANNING.

THOMAS H. MAWSON, HON. A.R.I.B.A.

In approaching the subject of street planning, we are taking up what is, from every point of view, the most important part of city planning, whether considered from the artistic or the strictly practical standpoint. Not only is it the subject which calls for the exercise of all the qualities and principles dealt with in the study of the civic survey, but on the intelligent and masterly solution of the many problems which street planning presents, depends the possibility of success in all those other problems pertaining to park systems, park and street equipment, and housing.

The street planning is the key of the whole subject of city planning, whether considered as a feature in itself or as a basis whereon to build up all the other features of the completed town, and thus we see that, unless every effort is made to deal with this item of town planning in an intelligent and a masterly way, or if a niggardly and parsimonious attitude is allowed to intervene, and prevent engineering and other difficulties from being boldly faced, and energetically dealt with, all our other projects for the health, beauty or convenience of the town must be crippled.

Whatever other economies are effected, there can be no more disastrous policy than not to lay down the roads on the best possible lines, whether they be the most expensive or no. We have always to remember that this feature, more than all others, in a town when once planned is planned for all time, and that if it is ever possible afterwards to rectify initial defects, it will only be at enormous cost compared with that of any necessary engineering involved in doing the right thing in the first instance. I have in my mind in saying this the case of a large estate in the north of England between two manufacturing towns. The first and most obvious necessity in its development was the main through route, crossing the estate diagonally and joining these two busy centres, and this was proposed by the man in charge of the preliminary work, but his strong recommendations were entirely ignored for the sole reason that, at one point, there would be an embankment about seventy-five yards long and some twenty-five feet deep in the centre, and this although, and notwithstanding that, for the rest of its route of over a mile, the road would require nothing but a little cross grading. This is, of course, an exceptional instance of unjustifiable timidity, but I have come across cases almost as bad in my own practice. I do not wish to suggest for a moment that Toronto would ever be guilty of such shortsightedness, but everywhere there are a few people who would be penny wise and pound foolish if allowed their way, and I, therefore, give prominence to this point at the beginning of this paper, that your hands may be strengthened

to resist the importunities of the fearsome, when the time comes to determine the routes to be laid down for future development in your own city.

The moment we approach the problem itself we find that expert town planners are divided into two great schools, each having their own methods of development, and known as the medieval and modern schools of street planners. The former of these argues that, whereas ancient medieval towns are more picturesque than modern ones, the true road to picturesque town planning is found by copying the old examples with their lack of all method or purpose. The fallacy of this argument is immediately apparent if we consider for a moment wherein the picturesque quality of old cities consist. Undoubtedly it is in their history and the spirit of romance which clings round ancient cities that most of their beauty is found, and, in its very irregularities, the eye seeks to read a purpose or cause, and so sees, written on the face of the town itself, just as one does on the human face, a history of its trials, vicissitudes, greatnesses and meannesses in a manner which strikes a sympathetic human chord and fills us with a love of the antique. When we point out the possibility of reproducing this haunting presence, this indefinable, sympathetic, almost human trait in old cities, we see the fallacy of trying to copy old methods in our town plans, and realize that any attempt to do so must produce an artistic sham, than which there can be nothing more irritating to the aesthetic sense.

There is another side of the question, however. These zigzag streets, now broad, now narrow, and meeting each other at all sorts of inconvenient angles, are quite unsuited to modern traffic requirements, which must be studied and met if our street plan is to be complete. Both on the practical and artistic sides of the question, too, there is a still further objection to this form of planning, for it invariably results in a multiplicity of little aims; on the one hand, little ends of streets and lanes embarrassing to the driver of wheeled traffic and little vistas, each with its little terminal clock turret or other feature, the constant repetition of which tends to become irritating to the artistic sense.

For these and other considerations arising out of them, and which are so obvious that, even if the time could be spared, I hardly need stop to labor them, we are forced to the conviction that, to copy old methods because they are old, cannot but be a fatal policy, and that street planning, if it is to be successful, must be the logical outcome of practical needs met and fittingly clothed with a garb of greenery, and its lines emphasized by the accompanying architectural features.

I do not wish, by this statement, to imply that all features which are spontaneous should be refused a place in street planning schemes, and that they should wear a manufactured air, owing nothing to Nature or local conditions. Far from it, for it

is by the skilful use of any advantages which local conditions place in our hands, and even by the effort to overcome disadvantages, that our best results are achieved, and new work is made to fall fittingly into its place, for what we are apt to call "distressing newness" in a newly developed neighborhood is merely this—that what has been done clashes with our sense of fitness through unsuitability to its environment, and that we look to time, that great remover of invidious distinctions, to complete our work for us and cover our mistakes.

As an example of a street in which a splendid result has been attained, partly by the aid of art and partly by the aid of natural features, we can have no better example than Princes Street, Edinburgh. Here we not only have the street itself well proportioned in length, breadth, and the height of the buildings, bordered with gardens, and so the best that art can provide, but we have the undersigned juxtaposition of the Castle and the fine view of Calton Hill, and, further still, the fact that the acropolis on the hill has never been finished, which is deplored by many people, but which we are inclined to look upon as one of those fortunate accidents to which the civic architect is so often indebted for his finest effects, for, were the large classic building completed, the effect would be heavier and less graceful than at present.

We thus see how many-sided the interests of the street planner must be if he is to make the best of his opportunity. While he must have a thorough technical training, he must avoid at all costs that fixity of outlook and inability to gauge the aesthetic possibilities of his subject, which is the bane of the man educated in exact sciences such as road engineering. In fact, the man who can successfully plan the roads of a city in advance so as to produce the best result from every point of view, must combine a knowledge of precedent with inventive genius and a complete mastery of technique, with the ability to throw overboard all his school-learned formulae, at a moment's notice, where the exceptional nature of the case demands this, and, again, while using every available aid of modern science, to take Nature as his guide and learn from her to clothe utilitaria with beauty and combine freedom with the ordered neatnesses inseparable from our highly complex modern existence.

If, then, the haphazard and slavish imitation of the old will not do for the modern town, it remains for us to determine the principles on which successful street planning must rest. In dealing with this subject, it is necessary to classify the streets to be formed into broad groups, according to their purpose, as the requirements of each kind differ in almost every way. This is usually done by dividing them into traffic and non-traffic streets, but, in most instances, such a division is too sweeping, and many different kinds of roads are thus lumped together quite unjustifiably, and no place is given to open spaces in either category. I would divide them into monumental open spaces,

recreational open spaces, traffic places, markets, shopping and business places and streets, main through routes, main residential thoroughfares, secondary residential streets, main arteries of the manufacturing district, secondary manufacturing streets. This gives us as many as nine main divisions, but even then cases are constantly arising of streets which cannot be included under any of these heads, without straining a point, and, of course, in special cases, there will be other special classes, such as the cathedral town with its close, the shipping town with its wharves, and so on.

With the open spaces, considered as such and not as traffic centres, dealt with in another paper, I propose now to examine some of the various attempts which have been made at orderly planning, and I think we shall find that the more the existence of these fundamental differences in the functions of different classes of streets and highways is recognized, the more successful is the plan.

We begin, then, with the "gridiron" plan, which is found in the remains of the Roman colonies; and even earlier than that, we have the earliest known effort at comprehensive planning in the ancient town of Kahun, as drawn and described by Professor Flinders Petrie, which is in this same gridiron system of planning, and again at New York, San Francisco, and many towns commenced during the last century, we have the same thing. In Bloomsbury, London, the same style of thing was done, and many other towns have been partly laid out in this manner.

That a style of planning so primitive and ancient is not well adapted to modern conditions we should be prepared to find, though it may sometimes be adopted for small areas with great success, especially if the architectural features bear strong evidences of a classical influence. Such a case is found in Edinburgh, where the district to the north of Princes Street is most successfully laid out on this principle, and it is much to be deplored that, when the coming of the railway upset the scheme, nothing was done to insure its replacement. Development ever since has gone on on the meanest lines.

The chief fault of the gridiron plan, from a practical point of view, is that it only allows of through traffic routes in two direction, and that traffic proceeding diagonally across the plan is compelled to take a zigzag course, which means much loss of time at every corner, not to mention the extra distance traversed. So greatly has this been felt in towns originally laid out on this principle that great efforts are now being made to superimpose diagonal lines into the original layout. Philadelphia is a very typical case.

Some cities have attained this combination of gridiron and diagonal lines by chance, or rather, by the compelling force of circumstances, which is a strong point in its favor. Generally

the diagonal lines have been evolved first and the square lines added afterwards, as at Calais, in France.

From the aesthetic point of view, the gridiron plan is also very undesirable, not only from its monotony, but also because it does not provide sites at the ends of long vistas whereon to place important buildings, and so the necessary perspective cannot be gained to view them properly. In many towns, too, where the streets are near together, this form of planning has resulted in there being no parcel of land big enough for the site of an exceptionally large building, and so excessively and undesirably tall buildings result.

Even the superimposition of diagonal lines will not entirely do away with these defects, though, that very much may be accomplished is evident from the detail plan of the proposals for a parkway from City Hall to Fairmount Park, which forms part of the scheme Philadelphia already referred to. Nevertheless, these efforts all partake of the nature of patchwork improvement, showing that the principle is at fault, and should not be adopted for new cities.

The better way is found when we come to study the traffic and other requirements to be faced. We then see that three-quarters of the traffic in every town proceeds to or from a point near the centre and the suburbs or surrounding country. This means that three-quarters of our traffic streets should radiate from the centre of the city to its boundaries, and further study will show that, in all ordinary cases, the remaining quarter of the traffic gyrated round that centre so that, if we do the best for the traffic, we have a plan which follows the lines of the spider's web.

A further development of the radial plan is what is known as the "ringstrasse," as it has been more extensively adopted so far in Germany than elsewhere. It consists of a ring of parks round the central part of the city, and, in old cities, has usually been obtained by clearing away obsolete fortifications. Vienna gives the best example, where a very fine use has been made of the opportunity there afforded.

In a theoretical case, then, our plan will consist of a series of radial streets and another system encircling the point where all the others join. At the latter point will probably be placed a large open square or plazza, in the centre of which may stand the chief building of the town, say, the cathedral, university, capitol or commercial exchange, according to whether it is an ecclesiastical, educational, administrative or commercial centre. We are, however, at once confronted with two difficulties, which are, that our radial streets will be too far separated in the outer parts of the town, and that so many streets, and consequently so much traffic, crossing at one point, will create great congestion in the central square, which is highly undesirable round an important building or group of buildings of the nature suggested. Here the ringstrasse comes to our aid and provides

not only trees, greenery, water and the songs of birds, within a moment's walk of the busy offices in the centre of the city, but also the opportunity of providing interlacing roads, which are really short cuts, diverting all traffic from the central square, which is not destined for a point exactly on the opposite side of it from that which it starts. It also provides for the arrangement of a series of secondary radial roads which do not proceed right into the centre of the town and so are not traffic routes, but merely means of access, and do not proceed out into the country, and so leave large sites available for industrial purposes or for development as individual units for residential suburbs.

Such a plan could never, of course, be carried out without adaptation to the needs and possibilities of an individual site, nor is it desirable that it should be, but the principle may always be used, and has been in many instances. It seems equally suited to a large town or a small suburb.

This indicates another way in which the radial system of planning surpasses the gridiron plan, that is in its adaptation to and recognition of the contours. Its adaptability to various conditions met with on the individual site, which are never the same on any two pieces of work, must necessarily be much greater than a collection of stiff straight lines crossing one another at right angles, and necessarily so near together that no deviation to meet the contours is possible.

In a number of instances the curved roads are not struck from a centre, but deviate somewhat. This is for the purpose of meeting the contours, and, in fact, these lines were laid down on a carefully prepared contour plan, as all such work should be. The adaptation of the lines of roads to the contours in this way has both practical and aesthetic advantages. Not only does it allow of easier gradients, making traffic easier, but it also expressed, in a logical and straightforward way, the prevailing characteristics of the surrounding country, and, as no two sites are alike, provides infinite variety.

The fan-shaped construction of this plan also brings up another point. Where the town is a port on the shore of a large river, or lake, or the sea, we have a variation in the traffic problems to be met, for not only will there be the traffic radiating from and gyratory about the centre, but also traffic proceeding from the wharves and warehouses along the shore inland in all directions. The fan-shaped plan allows of this in a very simple manner, for the circular roads, at the water side, become a means of reaching the centre of the town from every point where they touch it. This has evidently been realized by the city officials at Liverpool, who are at the present time constructing just such an avenue enclosing their city, and most town plans of recent date for cities on a waterway, such as Mr. Burnham's plan of Chicago, recognize it.

The plan of Copenhagen is very interesting in this respect

and shows that what was intended primarily as a gridiron plan has evolved these very characteristics from the force of circumstances in a manner particularly adapted to the site which is on a peninsula.

We have not yet exhausted all the advantages which the radial plan has over the gridiron, however, for it has the additional advantage of allowing of town gardens, squares, and open spaces, in the placing of which there is an obvious raison d'etre which is absent in the rectangularly planned town. In the latter, when you want an open space of any kind, you simply miss out one, two or three blocks of buildings, as the case may require, and the fact that this may be done anywhere at random gives the result the appearance of being the outcome of an arbitrary apportionment. In the radially planned town, however, there are numerous sites where roads divide, and so on, which call aloud for treatment as open spaces, and so, when this obvious need is fittingly met, we have a sense of fitness which adds greatly to the aesthetic effect. I need hardly add, too, that where two roads converge at either side of an open space, where drivers of traffic along one road can see that approaching the point of junction by the opposite road, there is much less danger of collision than where they meet suddenly round a corner in the square plan. In the radial plan, too, where they approach each other obliquely, the two streams of traffic unite or cross much more easily than where they cross one another at right angles.

This brings us to the important and, in some of its connections, very abstruse question, of traffic circulation and control. To deal at all adequately with this one aspect of street planning would be quite impossible in one lecture, but I think that we shall have enough time to look into some of the main problems in this department, the solution of which suggests methods of dealing with all the others.

The most important traffic question of all relates to those points in the busiest parts of the town, where the traffic has a tendency to converge on one point and so create congestion and delay. Those of you who know the Old Country will know what I mean when I instance the great traffic crossing known as "The Bank," in London. We have a local example here in Toronto at the corner of Yonge and Queen Streets.

The axiom one finds in books on town planning with regard to these places is that, "The multiplication of traffic places should be avoided." Now, while I entirely agree with what the writers mean when they say this, I think it may be far better put by saying that, "The points where traffic crosses should be multiplied, so that a large number of streams do not converge at any one point." This, I take it, is what is meant by the previous assertion, for streams of traffic proceeding in every direction must cross somewhere.

One way of overcoming the inconvenience of a number

of streams of traffic converging on, and recoiling from one point, which has been very much discussed of late, and which has attracted a very considerable attention, is what is known as the gyratory circulation of traffic. The principle is that, wherever the traffic enters the open space at the junction of the roads, it should all proceed round the space in one direction until it reaches the road leading away from the centre which it wishes to traverse, when it would naturally and easily fall out of the stream. This idea would work most excellently for street cars on rails, but there would be considerable difficulty in persuading the average driver to go round three parts of the circle to reach the point he wants, when the fourth segment is so much shorter, and the more democratic the local sentiment, the greater the difficulty. Many devices are proposed for overcoming this defect, the most usual being to make the roadways approach the open space tangentially, so as to bring the traffic into it pointing in the direction in which it is proposed it should gyrate. Unfortunately this involves the slowing up of the traffic at the point where it leaves the traffic centre in order to turn a sharp corner, thus neutralizing the chief advantages claimed for this system, and I have not yet seen a really successful attempt to overcome this difficulty. The aesthetic possibilities of the two systems are quite different. While there are numerous examples where the vistas down the four streets converge on one focal point in the centre of the square, which would, almost necessarily, be graced by a fine architectural feature, such as a clock tower or fountain, in other cases we have separate vistas not calling for such heroic treatment, but providing a fine opportunity for an extra bold treatment of the facade at the point where it comes across the view down the street.

There is yet another means of overcoming the dislocation of traffic, which occurs where two streams cross, and this is the superimposed thoroughfare, that is to say, by carrying one road over the other by bridge. We have done this in London by means of the Holborn Viaduct, and the plan has proved to be all that could be wished on the practical side, though one wishes that the bridge were more successful architecturally. Crescent roadways are provided to accommodate this traffic, and there is no valid reason, except expense, why these quadrants should not be adopted everywhere where two important traffic roads cross, whether they are superimposed or not.

Much more might be said on this most interesting subject, but we must now turn to the planning and arrangement of the streets themselves as separate units. We deal with the proportioning of streets, avenues and boulevards in another paper, and I only propose here to touch upon one or two of the most important practical questions relating to formation, width, route, and traffic disposal.

In Britain our great trouble is the standardized street. That is to say, the law has endeavored to find one kind of street

which will suit every possible case, and enact that this street shall be used always without variation. In England we call it the "by-law" street, and it is either thirty-six or forty feet wide, with the whole surface either macadamized or paved, and, up to quite recent years, trees could only be planted in it by persuading the law to shut its eyes to their existence. How this kind of thing works was very well illustrated by a case reported in the "Surveyor" a few years ago. The proprietor of a piece of ground, through which an exceptionally picturesque stream flowed tumbling over the rocks in a tiny ravine, desiring to make the most of this exceptional feature, proposed to preserve it as an open space in a railed-in enclosure in the centre of the street, placing eighteen feet of the thirty-six foot road on either side of the open space, and having the houses to face onto it. This was declared illegal, and, as the rental of the houses would not bear the cost of making two thirty-six-foot roads, one either side of the stream, the latter had to be placed in a culvert or sewer and the street carried over it. Note the result: Whereas, had the artistic arrangement first proposed been carried out, there would have been about a hundred feet of open space and light and air in front of each house; in the one adopted the house fronts were within forty feet of one another. Truly, in this instance, therefore, the immortal dictum of Charles Dickens' hero that "the law's a hass" has been vindicated.

I would, therefore, say to the people of Canada, whatever you do beware of the standardized road. Of course, municipal control of some sort is necessary, but it must be much more elastic than has usually been the case with us. What is really necessary is not to ensure that every road shall come up to a certain standard, but that it shall provide light and air to all the buildings bordering it, and shall be of sufficient width for the traffic. It should, too, be so planned that, should the traffic increase, the amount of road surface can be added to without expense and without setting back the frontages of buildings. Surely, what matters from the health point of view, is not the width of the road, but the distance between the houses on either side of it. These considerations have led the promoters of many garden city and suburb schemes to propose that land to a considerable width should be reserved for each road, and the frontage line of the buildings be kept well back from it. A strip in the centre, broad enough for immediate requirements, is macadamized or paved, and the remainder is laid down with grass and planted with trees, with or without flower beds, according to circumstances. This method has been adopted in the case of the new ring road round Liverpool already referred to.

Another method is to divide all roads into traffic and non-traffic, as in the town planning scheme already described, and formulate separate by-laws for each. Not only is this method far too wooden in its classification, but, as the non-traffic roads

are far the cheaper to make, there is a tendency towards their multiplication and the provision of too few through routes. Whichever system is adopted there is a tendency to the creation of little cul-de-sacs, which would be very difficult to police efficiently.

The great difficulty in planning a new street is to persuade the promoters of the scheme to make it broad enough. What looks very generous on paper, and even absurdly so, while the place is in a young and growing state, will be found to be less than is desirable when the town has fully developed. This is the reason why none of the recent town planning schemes in England have their main streets as broad even as the old village high streets, in the surrounding villages, and yet there are plenty of people who consider the widths laid down as excessive.

While these few notes must suffice for residential streets and non-traffic roads, for the others, a few words must be added as to the disposition and arrangement of traffic. This is a most important subject, which has come very much to the fore of late years, owing to the introduction of automobiles and waggons, which have revolutionized the question in England, and must do so in Canada also, though as yet, I understand, you have not the traction engine, with its three or four huge trailers holding perhaps ten tons of merchandise each.

We all know, however, and can easily see what enormous development of the commercial and manufacturing businesses must take place in this country within the next few years, and, this being the case, we must be prepared for an increase in the heavy traffic and provide for it in our street planning. It is accepted as a principle that, in planning streets where the traffic will be heavy, an effort should be made to keep light and fast traffic separate from heavy and slow moving vehicles. This is generally done in important streets by the provision of separate tracks for each class of traffic. In every case, whether separate tracks are shown or not, the fastest traffic takes the centre of the road and the slowest the sides, which is really the only practicable arrangement, though, undoubtedly, if the road slopes into the gutter at the sides, as it should, heavy wheeled traffic has a tendency to slide into the gutter, so that, in the case of that drawn by horses, they are, as it were, pulling uphill all the way. For this and other reasons mostly of a purely theoretical nature, I have heard it argued that the reverse order should obtain, and the heavy traffic take the centre of the street, but anyone who has watched really heavy traffic, say on London Bridge, will realize at once that this is quite impractical.

A factor which greatly complicates the whole question, especially in old towns such as London, is the obstruction caused by the vehicles standing by the sidewalk to discharge or load. If one compares the ease with which the traffic proceeds on one of the bridges across a wide river like the Thames in the centre of a large town, with the congestion which obtains on either

approach to the bridge, even though the latter are usually broader, this will be abundantly evident. In the planning of a new district, however, this can be very easily avoided, either by making narrow side tracks next to the sidewalk, especially for vehicles standing still, with, say, a strip of grass and trees between it and the main roadway, or, where this is undesirable, by the provision of a secondary means of approach at the rear of the building facing onto the main thoroughfare. In either case, however, there is no doubt that there should be statutory power to compel persons carrying on the business of public carriers, auction marts, or other business where goods are constantly arriving or departing, to provide proper yard space for their vehicles. In short, there should be some limit enforced as to the aggregate length of time in each day vehicles may stand still on each part of the highway, and persons causing them to exceed this should be liable to summons for causing an obstruction.

There is a further method of relieving congestion in the streets, which is by raising the street car traffic, with its railed track, above the rest of the traffic, or sinking it below. Of the two the latter method is by far the best, as, if we raise the railed traffic overhead, as in Berlin and Liverpool, the track shuts out the daylight, and the noise is deafening, whereas, if we sink it into a shallow subway under the street, as in the case of the London Underground, none will be aware of its existence until informed of it. Where the sunk track is arched over and the street carried above it, the expense is, of course, very considerably greater than that of laying the tracks on the surface, often prohibitively so, but in planning a new neighbourhood, there is no need to do this, for the cutting in which the cars run may be open to the sky for the greater part of the distance, with frequent bridges over to allow traffic and passengers to cross the street. This has also the advantage of letting daylight into the cutting, and where the space could be spared, the sides might be formed into sloping banks to be clothed with grass, flowering shrubs, ferns or creeping plants, according to the locality, or the street on either side of the track may be undermined to provide sidings for good waggons, which, if a track of the standard gauge were adopted, could thus be run off the railways right up to the warehouse door. Of course, in great cities separate tubeways would be provided for the collection and delivery of goods, but this combined passenger and goods street railway would suffice for all ordinary cases. The advantages in sinking the street railways into an open cutting are thus two. Not only is it possible, as just described, to arrange for goods traffic in a way that would not be possible on the surface, but also the cars can proceed at a pace which would otherwise be dangerous or impossible. The advantage where a traffic place is crossed, too, is very obvious.

Deep tube railways, such as we have in London, are only

suitable for certain geological formations, so I shall not discuss them at length. I may, however, say that it seems a great pity that more could not have been done to obtain wayleaves under the buildings instead of keeping strictly under the streets, as, in that case, they could have been better arranged, so as to have been capable of being driven at high speed. The chief objection to this class of conveyance is the time spent waiting for elevators, and attempts are being made at the present time to obviate this by the introduction of continuous moving platforms or staircases, which can be stepped onto at any time and immediately commence to convey the passenger up or down. The first of these, just opened as I write this, is so successful that it is anticipated that before long they will be adopted at all the London tube stations.

There is one great factor in the street planning of a city or town which is so important that I have reserved it for discussion at the last, that we may be able to give it individual attention. This is the relation the street planning must bear to the entrances to the city. In the past, before the advent of modern civilization, as we understood it to-day, the entrance to the city was by the imposing gate in the city wall, with its drawbridges and portcullis, as in the case of the gateway at Lincoln, which remains to this day, as do the gates to many other cities in the Old Country, such as Bristol and Coventry.

Even when the need for a fortified gateway has disappeared, it was still felt that this was an important point in the aesthetic sense and ought to be marked by a suitable erection, for in the year 1670 the bar, posts, and chains, which were all that were left to show where the old gate had stood up to the time of the Great Fire were removed, and the Renaissance archway, with a room over it, which we all know so well from pictures, was erected at the main entrance to the city of London. Even later, that is, at the end of the eighteenth century, when there could be no possible utilitarian necessity for a city gate, Sir John Soane and others formulated a strongly supported scheme for a portal entrance to London at Tyburn, that is what we now call Marble Arch, and the original of which is in the Soane Museum, in London. It was designed on very fine lines and would have formed a most imposing feature. The coming of the railway, however, upset all such plans and altered the situation entirely. Nowadays the grand portal entrance to every town is the principal railway station, and the oldest big railway in Britain, the London and North Western, fully realized this, and planned their station in London on what must have been, for the immediate requirements of the time, truly magnificent lines, though modern developments have placed even it somewhat out of scale.

In the city of the future, however, there is no doubt that the grand portal entrance is the railway station, and the traveler's first and most lasting impressions must not be of dirty back

yards and a muddle of traffic, such as surround most of the railway stations of the Old Country, but of a station so placed as to show the city at its best. There is no reason why the railway station should not focus and be emblematic of the city's commercial life, just as the church or cathedral is of its religious life. We in the Old Country are so unused to any such feeling that to propose that these two emblematic erections should stand facing one another at opposite ends of a finely proportioned boulevard, each suitably designed to express its several purposes, would tend to raise a smile, but there is nothing wrong with such a view. On the contrary, in fact, there is everything to commend it, and, where other conditions are favorable, there is no reason why it should not be carried out with the best possible results, thus helping to make the dead stones of the city's buildings speak of the living activities within.

UNIVERSITY OF TORONTO ELECTRICAL CLUB.

The first regular meeting of the club was held Wednesday evening, Nov. 8th. The president, Mr. F. C. De Guerre, made his inaugural address, thanking the members for their expression of confidence in him by electing him to such a responsible position. He outlined the constitution of the club and called the attention of those present to the splendid opportunities afforded the members, of hearing addresses on live engineering subjects, by men who are a success in their respective branches.

Professor R. W. Angus was then asked to address the meeting, his subject being, "European Laboratories, Workshops and Power Plants." The speaker, before introducing his subject, began by telling of many amusing incidents of his trip through Europe. He then described, by the aid of lantern slides, many of the technical schools and engineering works which he visited.

The speaker emphasized the fact that our school has been criticized for its lack of working models, and stated that, although the European technical schools have models of almost every conceivable device, they do not seem to be used by the students to any great extent, but simply exposed to view in glass cases. The subject of the use of small machines, such as we have in our laboratories, was mentioned. Professor Angus stated that in many of the German schools large machines are used for experimental work, but he believed that the principles of the work requiring the use of machines could be more effectively taught with the aid of comparatively small apparatus, the only real gain in using larger apparatus being a probable increase in efficiency.

The address was most interesting and instructive, and a hearty vote of thanks was extended to the speaker.

There is an erroneous idea among some of the men that because the club is called the "Electrical Club," it has no interest

in mechanical work. The constitution clearly states as one of the objects of the club, the reading and discussion of subjects of direct interest to third and fourth year mechanical and electrical students, and also the debating of such subjects. In accordance with this, the papers are divided equally between the two branches.

These two branches of engineering have such a close connection, it would hardly be a successful venture to have two separate clubs. Also, during a course in an engineering school, it is not advisable to make the education too narrow, and the subjects which are of interest to students in electrical engineering should be of equal interest to those who favor the mechanical branch. Especially should this be true of third year men, who, in very few cases, have decided definitely in which of the two professions they are the more interested. For these reasons the club executive hopes that all who are interested in these two branches of the engineering profession, especially third and fourth year men, will become members of the club and be regular attendants at the meetings.

Several very interesting papers have already been secured, and the year which is now before the club promises to be one of the brightest since its organization.

The club held an excursion on Nov. 8th to the Strachan Avenue sub-station of the H.E.P. Commission. Quite a number of the members availed themselves of the opportunity of seeing one of the most interesting high tension stations in America. Many other excursions to places of interest are being planned, announcements of which will be given later.

A NEW SCHOLARSHIP.

Since the beginning of the term a scholarship has also been offered by the Boiler Inspection and Insurance Company, of Canada, Limited. It is open to students of the third year in Mechanical Engineering, and is to be awarded to the man who stands first in honors in this department at the annual examinations. The scholarship is to the amount of $130.00 (the tuition fees for the fourth year). The donation has been very highly appreciated by the institution, and Mr. Roberts, the secretary of the firm, has been the recipient of praise and hearty thanks from the staff and the undergraduates. It is felt by them that the interest taken in the work of the institution by engineering organizations is very rapidly increasing, and no better acknowledgment of this appreciation is more encouraging than the granting of such a scholarship.

A. H. Munro, '10, is on construction work for Smith, Kerry & Chace on power development at Auburn, Ont.

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EDITORIAL

THE SCHOLARSHIP MOVEMENT

It was announced at a meeting of the Engineering Alumni Association, on Nov. 30th, that approximately $1,000 annually for three years had been provided for research scholarships in engineering in the University of Toronto, by the graduates of the Faculty of Applied Science. Also that the granting of one scholarship for the investigation of the dielectric strength of oils for transformers was being considered. With it the name of Mr. W. P. Dobson, '10, has been coupled, who, if the subject proves satisfactory, will carry on his research under the advisory supervision of Professors Rosebrugh and Price, and under the direction of the scholarship committee of the Alumni.

This announcement breathes of progress and of the probability of a series of individual and united efforts reaping material satisfaction. For a number of years a campaign was kept up, by personal solicitation and correspondence, and through "Applied Science," to increase interest among the graduates in

general, to the majority of whom the idea strongly appealed, not merely as a stimulus toward the engrossment of the student mind in scientific problems, but to the probabilities that appeared on the surface, of original contributions that might be made to the industries of the Dominion by the applications of scientific method and discovery. Research work in our institutions was pronounced away behind what it should be. The more study given to the question of scholarships, the more necessary seemed their establishment. The relation of the laboratory to the field of practice was rapidly growing closer elsewhere; the number of industrial problems requiring information of positive value, and at times, quickest possible solution was ever on the increase. The field for investigation in the newer sciences, for increased efficiency in the old, for comparative values of new methods, for the utilization of waste, for the behavior of materials of construction under severe conditions of stress, humidity, temperature, etc., were but a few of the many classes of problems calling for research.

That the facilities for this work in the University of Toronto, the wealth of student ability and ambition, and of adequate supervision, will now be brought to play upon research work, reflects much credit upon those who strove so long to make it a financial possibility.

PRELIMINARY WORK

The subject which Mr. Dobson is investigating, before beginning his active experimental work, is the dielectric properties of oils for transformers. It will require considerable study, upon his part, to collect all data relating to previous research, as much has been accomplished or attempted on transformer insulation, in both institutional and commercial laboratories. In itself this task is not easy, as much value is often attached to results of experiment, and publicity is prohibited from the viewpoint of commercial competitiveness. Nevertheless, as little time and money as possible should be spent in working up clues already solved.

Then follows the work of studying the goal in view. What remains undone in the study of transformer oils must be analyzed, and reasons for desirability of result made clear.

The suitability of the subject to the facilities of the University laboratories, likewise requires consideration, the space and equipment necessary for the furtherance of research, step by step, having a direct bearing upon the choice of subject, or an unforseen consumption of scholarship funds might attend any unsuspected branch unless it be thoroughly investigated at the outset.

These problems will occupy some little time; a report will be submitted, and the approval of both academic and financial committees met with. Then operations will, in all probability, begin in earnest.

As to the man to whom this first alumni scholarship is about to be given, the committee who are responsible made a most judicious choice. Mr. Dobson's high standing in academic duties, his abundance of experience in machine shop and assembly floors, in transformer and high tension work, in one of the best shops in America, (and not in that alone), his sterling qualities as a man, and his wealth of sound judgment and engineering knowledge acquired by strict attention to the best current literature, are all strong recommendations in his favor. Doubtless, the committee did not need to delve into research when considering his ability, his career while an undergraduate being a ready manifestation.

ONLY A BEGINNING

"Applied Science" hopes to see this undertaking on the part of the graduates the beginning of a vast co-operative interest in institutional achievement along industrial lines. It will result in the desired closer union of the academic and field phases of engineering in Canada. Much depends upon the success of this enterprise. The source of funds need not be expected to measure up to the gigantic field for valuable research, but if the interest taken by the comparative few becomes universal throughout the ever-increasing graduate body, the future industrial development of the province, and the accomplishments by research in the engineering laboratories of the University of Toronto, may be, by contiguity, mental associations among us less than twenty years hence. Again, much depends upon "making it go" now!

FROM NEW BRUNSWICK

We notice with extreme pleasure several references made in the october issue of the "University (of New Brunswick) Monthly," to Prof. J. A. Stiles, B.A.Sc., of the department of civil engineering of that institution. Mr. Stiles was an honor member of the graduating class of '07 and took post-graduate work the following year. Previous to his taking up the study of engineering he spent several years in Messina, Sicily; five years in the employ of the Canadian Pacific Railway, at London, Ontario; and also several years in the study of law. In 1909 he became a member of the engineering staff of the University of Toronto, and again in 1910, some intervening time being spent on engineering work in Detroit, Mich.

While employed as assistant superintendent of London waterworks Mr. Stiles became an active member of the American Waterworks Association. He has also been associated with the teaching staff of the Toronto Technical High School and the Ontario Agricultural College, at Guelph.

In his new work, for which his varied experience and executive ability makes him so well equipped, "Applied Science" wishes him success in good measure.

ARTICLES IN THIS ISSUE

The article on street planning in this number is condensed from one of a series of six lectures on Civic Art and City Planning, delivered in Convocation Hall, University of Toronto, before large and interested audiences, during the week of November 6th. Mr. Thomas H. Mawson, the leading landscape architect of London, England, was the speaker. Some idea of the comprehensive scope of the lectures may be gathered from the following list of subjects treated: City Building—the ideal and first principles of city planning; the Civic Survey, and the preparation of data, upon which to form a plan; Street Planning, with special reference to the traffic problems incident to manufacturing, commercial and residential areas; Park Systems, including town gardens, playgrounds, public parks, reservations and boulevards; Equipment of Streets, Parks and Gardens, for utility and adornment; Housing—model suburbs and villages, and the housing of the industrial classes.

The series aroused great interest, as city planning is one of the live questions in Canada at the present time, especially in the newer provinces, where great opportunities for good work along these lines exist.

The lectures were arranged by the co-operation of the University of Toronto, the City Council, the Civic Guild, the Board of Trade, and the Playgrounds Association.

In this particular paper Mr. Mawson has urged the necessity of providing for future growth with a view to best possible equipment for utility and adornment. The advantage of studying the origin and development of the cities of the present day, each with its own peculiar geographical, commercial, and sociological difficulties, many of them now unsurmountable, as a result of being unheeded at the proper period of growth, is open to members of councils and other public bodies in our towns and smaller cities. So many and varied examples are before them that no system of town planning should be adopted that is not the result of most diligent and exhaustive investigation. Such a system should provide for all likely development along residential and commercial lines, as defined by the co-operative judgment of the engineer, architect, sanitarian, and the citizen himself.

We hope to arrange the publication of another of Mr. Mawson's valuable lectures in a later issue.

In the November issue of this journal the first part of Dr. Dushman's paper, on Electrochemical and Electrometallurgical Developments in Canada, described the various plants at present in operation. The second part deals with the increasing field in Canada for these industries. The great wealth of mineral resources, especially in Ontario, British Columbia, and Nova Scotia; the numerous water-power facilities, well distributed over the whole country, especially in Ontario and British Columbia, the two greatest producers; the transportation facilities, rail

and water, well distributed also—when we parallel these conditions with Canada's standing among the other countries, first in the production of asbestos, first in nickel, third in chromite, third in silver, seventh in copper, eighth in gold, and tenth in coal, the field for the electrochemical engineer seems gigantic and well ready for development.

AN ARCHITECTURAL CLUB.

A meeting of the students in Architecture was held a few weeks ago to organize an Architectural Club in the University. Mr. J. B. K. Fisken, B.A.Sc., presided, with Mr. H. E. Heaton, as secretary, pro tem.

Mr. J. H. Craig, one of the speakers, dwelt on the fact that within the past five years the architectural course has developed from an engineering course with architecture, into a course in architecture and the finer arts with engineering. He pointed out the need of such an organization in the University as an Architectural Club, making the following motion, which was seconded by Mr. B. R. Coon: "In the opinion of this meeting, it is desirable to form a society to encourage research and study in architecture and by thus creating a proper architectural atmosphere to stimulate in the student greater love for his work."

A. W. McConnell, B.A.Sc., lecturer in Architecture, was present and gave his hearty approval of the organization, assuring it of every possible assistance on his part.

On Thursday, Nov. 30, a second meeting was held by the students for the purpose of completing the organization. Mr. Fisken presided in the chair.

The committee, consisting of Messrs. Craig, Coon and Heaton, appointed to draft a constitution, brought in its report. Each section was separately and thoroughly discussed, and finally the constitution was adopted. Professor C. H. C. Wright then spoke, giving some much-appreciated advice, and assuring the students of his hearty co-operation in connection with the club. A vote of thanks was tendered the committee for their services.

The society will be known as "The Architectural Club of the University of Toronto." Its purpose is to encourage research and study in architecture and to promote a spirit of good fellowship among its members.

Graduates or undergraduates of other departments and faculties, interested in architectural study, will be eligible for election to associate membership.

An election of officers took place on Friday, Dec. 1st, with the following results: President, E. Read; vice-president, J. H. Craig; treasurer, undecided; secretary, J. M. Robertson; 3rd year councillor, R. S. McConnell; 2nd year councillor, E. Hügli; 1st year councillor, M. Denison.

It is likely that the students in the Faculty of Arts, interested in architecture, will be invited to become members of this association.

THE ENGINEERING ALUMNI ASSOCIATION.

Since the close of last term the graduates of the Faculty of Applied Science, who reside in Toronto, have held several important meetings, which took the usual form of six o'clock dinners at the Engineers' Club. It is to be regretted that these dinners are not attended by a larger number of the "School" men who live in the city, since such meetings are called upon the event of some important subject to be discussed, or some prominent guest to be entertained. There are over 300 of the engineering alumni in Toronto, and only a small minority of these attend the alumni dinners.

At a dinner on May 19th it was announced that sufficient funds were in the hands of the executive committee for the beginning of two research scholarships in the Faculty of Applied Science and Engineering. The announcement was very enthusiastically received, as it marked an achievement that had long been pending.

On August 16th a farewell dinner was held for Mr. K. A. MacKenzie, secretary of the Association, upon the event of his departure for Vancouver. Mr. Mackenzie was the recipient of a beautiful silver tray, given as a token of esteem by the alumni in Toronto. His work for the Association had ever been energetic and of the kind that merited co-operation and admiration as well. Mr. Douglas made the presentation, which was followed by a number of short addresses from graduates and members of the faculty.

On Thursday evening, Nov. 30th, another dinner was held, this one in honor of Prof. A. G. Christie, of the University of Wisconsin, who was in town to address the Engineering Society that afternoon. About 75 members participated. In his remarks Prof. Christie referred with pride to the advancement made in the Faculty of Applied Science and Engineering in recent years. Since 1901, his year of graduation, his interest in the University is evidenced by occasional visits, although, unfortunately, they are restricted usually to the summer months, owing to the press of academic work in his own department.

At this meeting, also, Mr. Douglas, who presided, announced the granting of one scholarship, of which mention is made in another column.

M. W. Sparling, '09, is in charge of power house and large switching station at Trenton for the Sidney Electric Power Co.

F. S. Falconer, '09, is on geological survey work, Department of the Interior, Ottawa.

BOOK REVIEW

ADDRESSES TO ENGINEERING STUDENTS.

The volume bearing this title consists of a collection of some forty-four addresses and papers on subjects intimately or remotely connected with the engineering profession, written for the most part by engineers and teachers of engineering science, and compiled by Waddell and Harrington, consulting engineers, of Kansas City, Mo. Generally speaking, the papers are worth reading and a perusal of them will serve to acquaint the reader with the literary style and mental habit of some of the better known writers on engineering subjects of the American Republic. In this connection it is to be regretted that in their attempt to give "to students a true and adequate conception of the scope and dignity of the engineering profession," and to accomplish some "improvement in students' and young engineers' knowledge and command of the English language," the editors did not consider it advisable to draw from the works of their British fellow-workers, whose traditions, ethical standards and literary style, generally speaking, are not surpassed anywhere. Indeed, it is something of a significant commentary on the work, that in one of the papers on the value of English to the technical man, half a dozen instances of questionable English, consisting chiefly of the involved sentence, the colloquialism and the wrongly-used synonym will be observed. But even Homer nods.

The subjects discussed cover a wide field. Engineering ethics, the humanities versus the utilities in education, efficiency in educational methods, the engineer as a citizen, graduate study and research, the durable satisfactions of life, and the technical press, are a few of the topics, and from this list some conception of the variety in subject and diversity in view, may be had. In consequence the sequence and arrangement usually found in the properly-prepared textbook are necessarily largely absent, and it is not altogether clear how the editors propose to employ their work as a text in engineering schools. One would be puzzled to know under what designation a course from the volume would appear in an engineering curriculum.

The book contains some splendid "Advice to Freshmen," by Dean Shenehon, a sane, eloquent and scholarly paper on the relation of the engineer to society, by Colonel H. G. Prout, which alone is worth many times the cost of the book; some trenchant criticisms of engineering schools and methods of instruction, by Professor Dugald C. Jackson; a defence of the engineering school and its graduates, by Professor G. F. Swain; and an excellent paper on practical engineering, by Onward Bates, a past president of the American Society of Civil Engineers. In addition, there are papers by President Eliot, Professors F. P. McKibben, Ira O. Baker, Wm. H. Burr, Vladium Karapetoff, and others, including the editors. A quotation from "Two Kinds of

Education," emphasizing the need of diversified interests in the life of the engineer is given below. It gives the conception of the engineer and his work entertained by one of America's most versatile writers, most successful teachers, and most capable engineers. It is from the facile pen of the late Professor J. B. Johnson.

"For your own personal happiness, and that of your immediate associates, secure in some way, either in college or after leaving the same, an acquaintance with the world's best literature, with the leading facts of history, and with the biographies of many of the greatest men in pure and applied science, as well as of statesmen and leaders in many fields. With this knowledge of great men, great thoughts, and great deeds, will come that lively interest in men and affairs which is held by educated men generally, and which will put you on an even footing with them in your daily intercourse."

The editors have done a commendable work in compiling this volume, and the price at which it is offered, seventy-five cents, places its five hundred pages within the reach of every student. It could well find a place on the shelves of every prospective engineer.

PAST PRESIDENTS' DINNER.

The Past Presidents' Association of the University of Toronto Engineering Society held an informal dinner on Monday evening, Nov. 27th. Those present were: Messrs. Haultain, 1888-9; Carter, 1898-9; James, 1904-5; Loudon, 1905-6; Hogg, 1907-8; Campbell, 1910-11, and McPherson, 1911-12, the dates referring to term of office. It will be remembered that Prof. Haultain was the first student president of the society.

Mr. Loudon was appointed chairman of the Association for the coming year. Monthly meetings will be held and matters of live interest to the Society will receive attention and discussion.

R. B. Stewart, M.A., B.A.Sc., has been appointed lecturer in Mining Engineering.

Amongst the recent appointments to fellowships are those of W. V. Oke, '11, fellow in Surveying, and A. Fraser, '10, fellow in Physics.

Jas. H. Kennedy, '82, is assistant chief engineer of the Vancouver, Victoria, and Eastern Railway and Navigation Co.

W. E. H. Carter, '98, and A. H. Smith have formed a partnership as consulting mining engineers, under the firm name of Carter and Smith, Toronto. Both are graduates in mining engineering and have had considerable professional experience, the

latter chiefly in Mexico, and the former in Ontario, having been Provincial Inspector of Mines for some years.

D. L. H. Forbes, '02, has begun a consulting practice in mining engineering, with office in the Manning Chambers, Toronto.

G. A. Kingston, '10, is with the Montreal Engineering Company, with headquarters in Montreal.

R. J. Burley, '04, is district engineer for the Department of the Interior, Irrigation Office, Calgary, Alberta.

J. V. McNab, '06, is resident engineer for the Canadian Pacific Railway Company at Moose Jaw, Saskatchewan.

J. Paris, '04, is at present resident engineer on construction for the Transcontinental Railway, at La Tuque, Quebec.

C. H. Phillips, '10, is in charge of the engineering department of the Alberger Gas Engine Company's works at Buffalo, N.Y.

The registrations to date in the Faculty of Applied Science total 785. The first year numbers 267; the second 216; the third 142; and the fourth 160.

G. N. Ponton, '09, is with the West Canadian Colliers Co., Blairmore, Alberta.

F. R. Smith, '07, is with the Canadian Gowganda Silver Mines, Gowganda.

J. E. McDougal, a member of the class '09, was accidentally drowned by the capsizing of a canoe in the St. Lawrence, near Montreal, in June. Mr. McDougal was engaged in engineering work with Steel & Radiation, Limited, for several years previous to his death. An obituary will appear in the April issue of "Applied Science."

Mr. W. R. Davis, a member of the class '13, died at his home in Toronto, on June 12th. Previous to his death Mr. Davis was engaged in railway construction work for the Grand Trunk Pacific Railway Company, near Edmonton. Here he contracted painful illness, which necessitated his being brought home under great difficulties. He lived only ten days after his return.

C. O. Hay, '09, died at Montreal in September, as a result of an attack of typhoid fever. He was connected with the Shawinigan Light & Power Co., as divisional engineer at the time of his death. An obituary will appear in the April issue of "Applied Science."

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